STUDIES ON VOLTAIRE AND THE EIGHTEENTH CENTURY

EDITED BY THEODORE BESTERMAN

VOLUME LIX

COLM KIERNAN

Science and the Enlightenment in eighteenth-century France

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LES DELICES

GENEVE

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Science and the Enlightenment in eighteenth-century France

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by

Colm Kiernan

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ABBREVIATIONS

[for fuller particulars see the Bibliography]

JHI	*Journal of the history of ideas.*
RHL	*Revue d'histoire littéraire de la France.*
Studies	*Studies on Voltaire and the eighteenth century.*
A.-T.	*Œuvres complètes de Diderot.* 1875.
B.	*Œuvres complètes de Condillac.* 1822.
Best.	*Voltaire's correspondence.* 1953-1965.
C.	*Œuvres de Condorcet.* 1847-1849.
CE.	Condorcet, *Esquisse d'un tableau historique des progrès de l'esprit humain.* 1933.
DE.	Helvétius, *De l'esprit.* 1758.
DH.	Helvétius, *De l'homme.* 1818.
F.	Buffon, *Œuvres complètes.* 1855.
M.	Voltaire, *Œuvres complètes.* 1877-1885.
N.	*Œuvres complètes de Montesquieu.* 1950-1955.
R.	Rousseau, *Œuvres complètes.* 1822-1827.

PREFACE

This book is based on my Ph. D. thesis for the university of New South Wales. For assistance in guiding me through the massive source material of the eighteenth-century French Enlightenment, I am deeply indebted to professor J. McManners, formerly professor of history in the university of Sydney, and now professor of history in the university of Leicester, who was my supervisor.

I am indebted to dr Theodore Besterman for inspiration both from his own work and from his *Studies*.

My wife's encouragement and assistance is gratefully acknowledged.

Finally, I am thankful to the Institut et musée Voltaire for subsidising this publication.

INTRODUCTION

What was the contribution of science to the thought of the French Enlightenment? The answer to this question depends on how one views the Enlightenment. Were the *philosophes*, the writers of the Enlightenment, concerned to employ science, along with whatever other arguments they could find, to destroy Christianity? Alternatively, were they intent on using science, and anything else that seemed appropriate, to resolve problems which they had inherited? These issues are of fundamental importance. What is the state of these questions?

A definitive study of the French Enlightenment was provided by P. Hazard's *La Crise de la conscience européenne*, which was translated into English as *The European mind 1680-1715*. The 'crisis' that Hazard had in mind was the destruction of Christianity: 'What the historian of ideas must, in the first place, put down to their account is the immense effort they made to transform into a non-Christian Europe the Christian Europe that confronted them'[1].

Hazard took it that the *philosophes* were a united group, which helps to explain their impact, but at the expense of their logic: 'There exists an essential disharmony . . . this same philosophy melted together into a single doctrine empiricism, Cartesianism, Leibnizianism, and finally Spinozism'[2]. This paradox lies at the heart of the monolithic interpretation of the Enlightenment. What is most characteristic about Hazard's interpretation is that he showed the *philosophes* as activists, who employed all the means at their disposal to destroy Christianity. He portrayed them seizing on the current fashion for books on travel to foster

[1] Hazard, *European thought in the eighteenth century*, p.110.

[2] *ibid.*, p.307.

relativism[3], and criticising contemporary Europe by comparison with the cultures of newly-discovered countries. The outcome was the cult of the 'noble savage'[4].

This interpretation of the thought of the Enlightenment, as an activist force, was extended and strengthened by the work of D. Mornet[5], who, like Hazard, saw here the dawning of the modern world, atheistical and technological. Far more than Hazard, Mornet argued that a characteristic feature of this new age is its concern with science and with scientific method, a determination to get at the facts, and to draw inferences from them. This view of the Enlightenment has the support of other influential writers, for example, G. Lanson[6], and has long held the field.

A feature of this kind of interpretation is the typical assertion that the thought of the Enlightenment was primarily empirical in its orientation. So Mornet, in reviewing Muller's *Essai sur la philosophie de Jean d'Alembert*, commented: 'J'ai essayé de montrer par ailleurs, qu'il ne fallait pas exagérer l'importance de ce rationalisme abstrait et qu'il avait été combattu par le développement d'un esprit expérimental et réaliste'[7]. It is normally claimed that this empirical orientation derived from England, from the science of Newton and the philosophy of Locke. So for P. Sagnac: 'Tout un système de philosophie générale va se développer, imité des Anglais et de Locke, justifié par la science expérimentale'[8]. A disadvantage of such interpretations is that they run the risk of being anachronistic, of reading back into the past a rigorously empirical method which, while it is a

[3] *ibid.*, pp.19-27.

[4] *ibid.*, pp.28-38.

[5] for his views on eighteenth-century French science see *Les Sciences de la nature en France au XVIII^e siècle*. For the broader issues raised, see D. Mornet, *Les Origines intellectuelles de la révolution française (1715-1789)*.

[6] 'Sur l'Histoire de l'esprit philosophique en France avant 1750', *RHL* (1912), xix.1-29, 293-331.

[7] *RHL* (1928), xxxv.272.

[8] *La Formation de la société française moderne*, ii.78.

characteristic feature of much present-day scientific work, was far less the practice in the eighteenth century.

In sharp contrast is the point of view of those who reject the claim that the thought of the Enlightenment was modern and activist, who prefer to see it as having been medieval rather than modern, or passive rather than active, in its emphasis. C. Becker was most influential amongst those who argued for the Enlightenment as leaning more to the past than to the present in its orientation: 'I shall attempt to show that the Philosophers demolished the Heavenly City of St. Augustine only to rebuild it with more up-to-date materials'[9].

A characteristic feature of this and other such interpretations, is too see in the Enlightenment not the beginnings of modernity, but rather a re-discovery of the past. While still standing for a secularisation of thought, the Enlightenment is now taken to represent a development from within a Christian religious framework, not something that occurs from outside. This leads on to a consideration of whether the religious framework in question was primarily a Roman Catholic or a Protestant one, a question resolved in favour of the latter by Becker, and by his followers, and for the former by E. Cassirer[10].

A disadvantage of Becker's argument is that it seems to involve an under-estimate of the importance of the thought of the Enlightenment. The protagonists are seen working from within religious parameters of which they were unaware, so that they were not enlightened at all, merely confused[11].

More recently, Becker's interpretation has been varied and strengthened by R. R. Palmer, who sees in the participants men self-consciously working from within religious frames of

[9] *The Heavenly city of the eighteenth-century philosophers*, p.22.

[10] 'For now the controversy between Luther and Erasmus arises again, but this time it is decided in favor of the latter'; Cassirer, *The Philosophy of the enlightenment*, p.160.

[11] for other criticism, see *Carl Becker's heavenly city revisited*, ed. by R. O. Rockwood, pp.v-xxv.

reference inherited from the past: 'The great work of the philosophes was to supply a new faith, which more fully than traditional Christianity, took account of the facts of the new age, giving a supreme significance to the rise of science, the growth of the state, the improvement of civilisation, the increasing attractiveness and livability of this nether world'[12]. As regards France, the framework was a Roman Catholic one. In Protestant centres, for example in Geneva, a similar development was taking place from within a Protestant religious condition[13]. This position has been greatly expanded and consolidated by another influential writer on the French Enlightenment, namely L. G. Crocker[14]. His argument is that Enlightenment writers were primarily concerned to resolve moral problems which lie at the root of Christian thought. They failed to do so, because what they were trying to achieve is impossible. Their work exposed a moral crisis, which is our inheritance.

The emphasis in this interpretation is on a historical, not a scientific, approach by the writers in question. So P. Masson, who was a pioneer of the interpretation advanced by Crocker, when reviewing D. Mornet's *Les Sciences de la nature*, wrote: 'La "philosophie" d'un Voltaire, d'un Fréret, d'un Boulanger, même d'un Helvétius et d'un d'Holbach, et d'une manière générale, de presque tous les Encyclopédistes, est beaucoup plus une philosophie historique que "scientifique"'[15].

An important and characteristic difference between these two kinds of interpretations is that one is positive, the other less so. One emphasises the *philosophes* as agents of change, while the other sees them responding to what was happening about them.

[12] *Catholics and unbelievers in eighteenth-century France*, p.20.

[13] J. McManners, 'Paul Hazard and the crisis of the European conscience', *Arts* (1962), i.73-86.

[14] *An Age of crisis: man and world in eighteenth-century French thought*, and *Nature and culture: ethical thought in the French Enlightenment*. For his criticism of differing interpretations, refer 'Recent interpretations of the French Enlightenment', *Journal of world history* (1964), viii.426-456.

[15] *RHL* (1912), xix.948.

In the first instance they are the challengers, out to destroy existing orthodoxies; or else they were trying to resolve problems always present in the minds of men. Their work either represents a ferment from within a Christian tradition, or else it was an attempt to destroy Christianity from without.

The difference between these interpretations can be seen at all levels, especially in their contrasting view of what the *philosophes*, the writers of the Enlightenment, were trying to achieve. For Mornet, they were empiricists working for the triumph of science: 'Par philosophe entendons surtout, comme on l'avait fait si longtemps, celui qui s'occupait de la science'[16]. Crocker takes it that the *philosophes* were rationalists, concerned with broader issues than science, rather with ethical problems: 'By philosophe it is well known by now we designate that group of eighteenth-century writers who, refusing to abide by Christian doctrines and dogma, and by the authority of the Church, searched for the truth in the light of reason and experience'[17].

What is important for our present purpose, and what these interpretations have in common, is the recognition of a clear distinction between orthodox Christians, on the one hand, and *philosophes*, on the other. The *philosophes* all rejected the Christian doctrine of original sin. For the time being, it can be left an open question why they rejected it, and what they proposed to put in its place.

It is now being realised that the thought of the Enlightenment is far more complex and varied than was formerly believed[18]. Analysis of eighteenth-century French science supports this view, and will lead to new insights on the Enlightenment.

The interpretation to be proposed here differs from those that have come before. Here it will be argued that there was a debate

[16] *Les Sciences de la nature*, p.144.
[17] *An Age of crisis*, p.xv.

[18] this point is made and developed in a penetrating analysis by Th. Besterman, 'Reason and progress', *Studies* (1963), xxiv.27-41.

on science in the French Enlightenment which has passed unnoticed, but which raised questions of fundamental importance for science and for thought generally. The writers of the Enlightenment spent their efforts in trying to resolve the problems so raised. The debate was between those who wanted to mechanise the world picture and their foes. The latter rejected the mechanical science of Descartes and Newton in favour of a variety of alternatives, all finding their scientific rationale in the 'sciences de la vie', in biology, medicine and botany.

The controversy extended from science into ethics and religion, and raised issues which are still unresolved but which need urgent attention. The age-old question of whether the will is free or 'in bondage', which was the central issue in the Reformation era, appeared again in its modern form. Instead of being argued with reference to theology, science was now employed to resolve the points at issue. The result was a heated controversy on the nature of god, and of man, and of man's relationship to nature.

It has been customary to view the thought of the Enlightenment as an integrated whole. Here it is seen as a movement split within itself into two irreconcilable divisions hitherto not recognised, namely, the mechanists and their foes who upheld an organic approach. This division cut across all others, so that atheist fought atheist, and one set of deist denounced the other. What is presented here is a picture of intellectual disintegration, with ourselves as the inheritors.

The science of the Enlightenment is seen to have been important in providing the battle-ground on which the concepts of the Enlightenment were tested. Science was the midwife in the generation of such ideas as 'progress', 'democracy' and 'atheism' in their modern forms. The writers of the Enlightenment employed science to provide a rationale for conclusions reached by other means. The conclusions reached, and the argumentation employed in their defence, are our heritage from the Enlightenment. It is high time that we examine the nature of our inheritance.

Briefly, the major difference between this and previous interpretations is in the discovery of the importance of the hitherto ignored debate between the mechanists and their foes. This is taken to have been the point on which issue was joined in the French Enlightenment. The consequence is a re-interpretation of the thought of the Enlightenment. This thesis is stated and illustrated in chapters one and two. Chapters three to seven are intended to establish it as applied to the thought of the French Enlightenment.

CHAPTER I

The Debate on science

A central problem facing the intelligentsia of eighteenth-century France was to come to terms with the scientific achievement of the previous century. The inheritance was chiefly from Descartes and from Newton, and is best represented as a 'mechanisation of the world picture'[1]. The implications of the new science were worked out in many different ways. The Newtonian synthesis represented the mathematisation of physics and of astronomy. This was a major advance on what had been before, and it put the physical sciences on their modern footing. The life sciences, chemistry and electricity, remained as they were. The result was a cleavage between two different sorts of science.

Conflicting attempts were made to resolve the situation. One was to develop the mechanical world view of Descartes, and of Newton, as applied to physics and astronomy, and to extend it into other branches of science. This was the achievement of such scientists as Alembert and Lagrange, and it found its foremost populariser in Voltaire. The characteristic procedures of those who expounded this mechanist type of solution were:

1. To argue for the primacy of a mathematical treatment, or of quantification, as the method for science. This use of mathematics encouraged universalist ideas, and tended to discourage ideas of major change.

2. To employ mechanical terminology, and to argue from cause to effect.

3. To see the world as a machine which obeys laws of science.

[1] this is the title given to his book by E. J. Dijksterhuis.

The characteristic features of the mechanist approach as applied to the sciences individually were:

1. *Physics*: mechanists were normally atomists who supported the belief that the stratosphere is a void. They were usually 'big bang' theorists, believing that the universe began to exist at a point in time.

2. *Geology:* they were usually water theorists who believed that matter derives from water, and that the world was so derived. Eventually the waters receded and the world emerged. It was in its present shape, which it has not changed since. Alternatively, some claimed that the world was created in its present shape without the use of water. All agreed that Newton's laws applied at all times in the history of the universe.

3. *Biology:* mechanists were preformationists. That is, they claimed that god made the original germs, from which all later generations derive. Each generation follows in an assembly-line type of procedure from the previous one, in a continuous cause-and-effect relationship.

4. *Chemistry:* mechanists were normally phlogiston theorists. That is, they argued that changes which occur during combustion are due to a cause-and-effect relationship between the fire and the body being heated. During the process an invisible element, phlogiston, passes from the fire to the body, or else phlogiston is released from the body by the force of the fire, another mechanical analogy.

5. *Electricity:* the Cartesian two-fluid theory was generally accepted, involving effluence and affluence, and proceeding by mechanical analogies.

6. *Medicine:* they looked on the human body as a machine, except for a soul which, as it is invisible, did not interfere with their research. They were proponents of irritability, or the stimulus from outside, not sensitivity, or the logic of organic structure, as the dynamic factor in human movement.

A diametrically opposite alternative to the mechanical world picture was to resolve the situation completely in favour of the

life sciences. This stood for a total rejection of the mechanist position. In this alternative world view, the emphasis was on fermentation, and the study of life was seen to be all-important. The microscope was meant to take the place of the seventeenth-century emphasis on the telescope as a means to the discovery of truth. These strongly contrasting tools may be employed to symbolise a split within science which was not resolved until the nineteenth century when the importance of the achievement of Maupertuis, who pioneered the theory of evolution, was realised and consolidated. Up to then, the scientific study of life, on the one hand, and of nature, on the other, diverged, and could not be satisfactorily integrated.

Less is known about the other tradition, namely, that of the life sciences. Lavoisier and Maupertuis were influenced by this approach. Their chief supporters amongst the popularisers of science were Montesquieu, Diderot and Rousseau. The characteristic features of their position were:

1. They rejected the use of mathematics as the basic technique for the sciences. They tended towards nominalism. They believed matter to be in a constant state of change, so that mathematics is not an appropriate tool for analysis.

2. They rejected mechanical arguments as misleading.

3. They rejected the idea of the world as a machine. They looked on it as being in a condition of change, characterised by growth, by death and re-birth, and not at all constant.

As applied to the individual sciences:

1. *Physics:* they normally supported a corpuscular theory, or were ether theorists. In extreme cases they rejected the idea of laws of science in favour of catastrophism. They always rejected the universalist claims of the mathematical physicists. They argued for the eternity of matter, from which life issues.

2. *Geology:* they usually rejected the idea of the deluge as having played any significant rôle. They believed that the early history of the universe was one of major upsets and revolutions, and that

Newton's laws did not apply then. Most claimed that they would not apply in the future.

3. *Biology:* they believed in generation by fermentation through which is developed the seed of life. Preformation was rejected. To them, generation depends on the environment, and on climate, especially on the air, which determines the kind of life that issues. Matter in motion produces heat, and life emerges. To them, the rôle of heat was of crucial importance in inducing change. Many were proponents of spontaneous generation.

4. *Chemistry:* they rejected the mechanisation of phlogiston theory, where the emphasis was placed on the significance of fire as the cause of change. Their emphasis was on the air as an agent of change. Combustion was explained as a sort of fermentation in matter, as a chemical reaction induced by the air, with heat as an additional catalyst rather than a cause. Some exponents were concerned with the transmutation of metals. All worked in the tradition of the medieval arts and crafts, and of technology.

5. *Electricity:* this was seen as being closely related to heat, and, at the same time, as a by-product of fermentation. It was seen to have within it an invisible vital force, which might act as a catalyst in fermentation, and thereby induce life.

6. *Medicine:* they strongly emphasised the importance of drugs in changing the human constitution. They were often keen students of physiology. They were proponents of sensitivity, rather than of irritation, as the dynamic factor in human movement.

It is necessary to detail these two positions because historians of science normally favour one side and discount the other as faulty, or as unimportant, or both. This is completely to misunderstand eighteenth-century French thought.

It was in biology that the mechanical world view met with most opposition. The traditional link between the life and the physical sciences was the 'chain of being'[2] concept. This related

[2] A. O. Lovejoy, *The Great chain of being*, pp.183-207.

man to the universe by providing him with a place in a scalar system. The 'chain of being' begins with inanimate matter, ascends to the lowest forms of organism, through animals, to man, and through the angels and the universe, to god. Man rules on earth, while god is king in heaven. The new science, with its lop-sided application to physics and astronomy, was extended in an attempt to mechanise the 'chain of being' concept. The result was preformation theory, which was the reigning orthodoxy in eighteenth-century France[3].

Although there were many variants[4], all preformationists held that life originates in germs which date from the beginning of time, and which unfold in each generation, to shed, as an onion sheds its skins, to bring forth new life in its own image[5]. Preformation was normally associated with 'emboîtement', the theory that, when all the created germs reach adult form, when all the potential of the original germs is realised, the species will become extinct. The life cycle has a clearly defined beginning and an equally decisive end to it[6].

It was Harvey, by his assault on Aristotelian biology, who prepared the way for the preformationists. By his use of detailed anatomical observational procedures, he was well able to destroy the Aristotelian theory which explains generation in terms of matter already present inside a woman, which is triggered into life by the male spermatozoa. Harvey found it far more difficult to develop an alternative theory. His examination of the habits of hens led him to the belief that all life comes from eggs. He coined the phrase 'ex ova omnia' to pioneer this step towards a new

[3] 'après 1705, la préexistence règne sans conteste sur la science officielle'; J. Roger, *Les Sciences de la vie dans la pensée française du XVIII^e siècle*, p.364.

[4] E. Farber, 'Variants of preformation theory in the history of chemistry', *Isis* (1963), liv.443-460.

[5] for what follows on preformation, refer Roger, pp.314-453, and E. B. Gasking, *Scientific investigation of generation 1650-1910*, pp.68-160. This material is re-worked here.

[6] 'it was preformation with emboîtement which constituted the true preformation theory'; Gasking, p.59.

theory of generation. This was eventually supplied by the preformationists.

Preformation was successful as a theory of biology not only because it fitted well with the mechanical world view of Descartes and of Newton, but because it could account for the facts known at the time better than could any other theory. For example, it could explain the challenge of the apparently new features which appear as the embryo develops as having been present all the time, but as only just becoming visible to the eye.

Preformation had its critics in eighteenth-century France, notably Maupertuis, Buffon and Wolff. Maupertuis was by far the most dangerous of these, because he based his case against preformation almost exclusively on facts about hybrids, monsters and inherited variation. Subsequent events vindicated this approach[7]. If new species can be developed, and Maupertuis strove to develop some[8], then preformation must be wrong, as the germs for the new species could not have existed from all time.

Maupertuis explained monsters differently from the preformationists, who saw them as mistakes due to some errors of the birth or pre-natal period. He explained monsters as contingencies which might well be part of the total process, but for which no germs existed from the beginning of time. Finally, through the study of polydactyly, he came to the conclusion that the species can and does change, so that preformationist theories, which could not allow for change, must be inappropriate. Evidence about the inheritance of polydactyly has rightly come to be seen as perhaps the most telling case against preformation that was put during the eighteenth century[9].

It is significant that the objections of Maupertuis, which would have led biologists away from preformation, were not followed

[7] *ibid.*, p.121.

[8] B. Glass, *Maupertuis, pioneer of genetics and evolution*, pp.72-75.

[9] Gasking, p.121.

up. Instead, eighteenth-century French biologists engaged in a debate on regeneration. This happened because ferment theorists were committed to establishing spontaneous generation, which would give standing to their science, and would, at the same time, demolish the preformationist position. The philosophic interests of the scientists were allowed to triumph over their science. It was not until the next century that Maupertuis's position was extended and secured by Darwin.

There were, at the same time, some scientific reasons why the debate between the preformationists and the ferment theorists should be allowed to lead away from Maupertuis's work. Trembley's revelations about his polyp, revealed to the Académie des sciences in 1741, in a paper by Réaumur[10], took the centre of the stage. It captured the imagination to think that the polyp, when cut into pieces, continued to live through each piece. From here it seemed only a short step to spontaneous generation, which would vindicate the ferment theorists. The step was not, however, taken.

Preformation theory was the price paid to mechanise the world picture. It was not generally accepted as an advance on the 'chain of being' concept, one reason being that it required no change in the human constitution from the beginning of time. By comparison, the 'chain of being' concept was scalar, and had the advantage that it allowed of new species, should they be discovered, as part of the system[11].

There was another important reason for the greater appeal of the 'chain of being' compared with preformation. The 'chain of being' was useful in providing a bridge between the life and the physical sciences. It offered an explanation of life as a stage in a process between the inanimate and the spiritual, thus allowing the physical and the life sciences to co-exist or to be integrated.

[10] A. Vartanian, *Trembley's polyp, La Mettrie, and eighteenth-century French materialism*, p.497.

[11] Lovejoy, pp.231-237.

Preformation, on its side, also provided a bridge; but it represented the subordination of the life sciences, and the victory of the new mechanist approach.

While it was possible for its critics to point to objections in the theory of preformation, it was far more difficult to establish an alternative. Whereas the weakness of the Newtonian synthesis was that it referred to only a few branches of science, its critics were in a worse position than its defenders, having no equivalent synthesis of the life sciences. While preformation provided a comparatively weak link in the science of the mechanists, it was necessary for its critics, in order to destroy it, and all it represented, to establish a consistent rationalisation of each of the individual sciences. Unless this was done, the danger was that the destructiveness of the critics would be far more successful than their ability to substitute something else, that the advance achieved by Newton would be the precursor not to further progress, but to a total collapse.

While preformation was the accepted orthodoxy, it had many critics. Those who rejected preformation, for example, Montesquieu, Rousseau, Diderot and Buffon, normally completely discarded the mechanical world picture. Their problem was to find an alternative explanation. The danger they ran was of relapsing into irrationalism. The search for alternatives resulted in a study of the chemistry of the alchemists[12], and the physiology of Paracelsus[13], and the science of Van Helmont[14]. These were the proponents, before the eighteenth century, of the importance of ferment. Their work was revived in answer to the challenge posed by the mechanists.

What these alternatives all had in common was a rejection of preformationist orthodoxy, of fixity, in favour of change. For the alchemists, change is achieved through the use of drugs, and

[12] M. P. Crosland, *Historical studies in the language of chemistry*, pp.227-244.

[13] H. P. Pachter, *Paracelsus: magic into science*, pp.167-176.

[14] J. B. Partington, *A History of chemistry*, ii.209-241.

for Van Helmont it is by ferment. Their science worked from man to nature, not from nature to man. Conversely, the science of the mechanists worked best for nature, and far less well when extended to man.

There was less in common than there was in opposition between these two scientific traditions. The roots of their difference can be traced back at least as far as Greek science, to the problem of the study of 'the one' and 'the many'[15]. It is not to our purpose to discuss the history of these traditions.

Amongst the scientists, probably the foremost exponent of ferment theory in eighteenth-century France was Guillaume François Rouelle[16]. He made his major impact as an instructor at the Jardin du roi between 1742 and 1762. Diderot studied under him for three years and was so impressed that in his *Notices sur Vanloo et Ruelle* he described him as the 'fondateur de la chimie en France' (A.-T. vi.408). Rousseau attended his lectures (R.xviii.119; *Confessions*). He also taught Lavoisier[17]. He specialised in demonstration, and developed very sophisticated equipment for the purpose. Galande's balance, described in the *Encyclopédie*, which had been made for Rouelle, already possessed the characteristics of a precision balance[18].

Ferment theory was widely accepted in eighteenth-century Germany[19]. It made for the glorification of mother earth, the source of life, and paved the way for the development of romanticism, the cult of nature worship, as expounded, for example, by Goethe. Eighteenth-century French exponents of ferment theory, especially Montesquieu, acknowledged their debt to the work of the Germans: 'Vous entendez bien que mille chimistes allemands, qui manipuleront sans cesse et ne se détourneront

[15] C. E. Raven, *Science, medicine and morals*, pp.189-191.

[16] C. Secrétan, *Guillaume-François Rouelle*, pp.187-192.

[17] H. Guerlac, *Lavoisier, the crucial year*, pp.18, 119.

[18] M. Daumas, *Precision of measurement and physical and chemical research in the eighteenth century*, p.423.

[19] 'la chimie allemande, fidèle à la tradition de Van Helmont'; Roger, p.291.

jamais, trouveront plus aisément les effets de la combinaison de certains principes en chimie que mille Anglois qui étudieront quelque principe de la chimie, mais s'occupent les trois quarts du temps à raisonner sur la religion et sur le gouvernement' (N.ii.73; *Pensées*).

The controversy in biology was in fact a three-way debate between preformationists, ferment theorists and attractionists. Just as the ferment theorists rejected the preformationist orthodoxy of the mechanists, neither did they accept the attractionist argument of Buffon and his supporters, with its emphasis on sexuality as the key fact of generation. They feared that sex, or attraction, represented the mechanist world view in another form. Attraction seemed to them to represent Newton's mechanical law of gravitation, which was known in the eighteenth century as attraction, applied to the life sciences. They had their own theory, that life comes out of the earth. It seemed to them that sex plays a comparatively minor rôle in the story. This was particularly the position of those who accepted spontaneous generation.

The ferment theorists gained ground as a result of controversy amongst the preformationists, which had the effect of weakening their position. This is especially perceptible from a consideration of the debate amongst preformationists as to whether the man or the woman is the bearer of the preformed germ[20]. The ovists, who gave primacy to the woman, employed the testimony of Harvey, and later gained support from Bonnet and Spallanzani. They were in the majority amongst eighteenth-century French biologists. The alternative view, that the germs are present in the male spermatozoa, the belief of the animalculists, notwithstanding that it was held by medical experts such as Boerhaave and Andry, was held by relatively few eighteenth-century French biologists[21].

The ferment theorists capitalised on the debate, to develop their own doctrine, that both sexes might well have similar seminal

[20] *ibid.*, pp.318-320.

[21] Gasking, pp.75, 141.

fluids, which was Diderot's argument in *De l'interprétation de la nature* (A.-T. ii.17). In his *Fragment botanique* Rousseau argued along similar lines (R.xi.219). This should be compared with the alchemical interest in squaring the circle 'to make the sexes one whole'[22]. Such considerations were the basis of the transformist theories of Jean Baptiste Charles Robinet (1735-1820) and of Benoist de Maillet (1659-1738), the author of the *Telliamed*[23].

The article by dr d'Aumont in the *Encyclopédie* argued for ovism and did much to popularise the attractionist cause[24]. The view of attraction, as represented by the female, gained greatly as a result.

The short-term result of the debate in biology between the preformationists, the attractionists and the ferment theorists was that victory seemed to be passing from the preformationists, who relied on heredity, to the attractionists and the ferment theorists, both of whom emphasised the environment as being far more important. This was a result of their combined impact, but, in particular, a measure of the success of Buffon and his associates at the Jardin du roi, who were kept up to the mark by their critics amongst the ferment theorists, such as Rousseau, and by the preformationists, who also criticised. In the debate the attractionists had the advantage that they occupied the middle of the road.

By 1760 preformation, though still the reigning orthodoxy, had lost much of its dynamic, and might have been supplanted, had not Haller, Bonnet and Spallanzani given it new life. From 1762 to his death in 1793, Bonnet worked to put preformation on a more scientific footing[25]. He was already well known by 1742 when, as a disciple of the famous Réaumur, he had worked to establish parthenogenesis. When he threw his weight behind ovism and preformation, he gave these theories tremendous support[26].

[22] Crosland, pp.32-33.
[23] J. Rostand, *General biology: the eighteenth century*, p.141.
[24] Gasking, p.141.
[25] *ibid.*, pp.94, 177.
[26] Rostand, p.519.

Spallanzani's experiments with frogs, which, because of their rigorous pragmatism, made a lasting contribution to biology, were used at the time to supply a seemingly incontrovertible proof of preformation[27]. His long argument with Buffon, which he won, popularised his cause and represented a win for preformation over its chief critic. Preformation was given a new lease of life.

More significantly, as the battle developed, there was the danger of a cultural split within science itself, that the traditional integration of the sciences would end in a cleavage between the physical and the life sciences, with each side trying to extend its own rationalisation to the other. Two further possibilities presented themselves: the physical sciences might go one way, and the life sciences another; or else one branch or the other might succumb to irrationalism. The 'age of reason' represented a time of travail for reason. It was not until the next century that scientists were enabled to resolve the questions at issue, as far as they affected science.

The debate within science resulted in scientific advance in eighteenth-century France. Paradoxically, the attempts made to reconcile science with other branches of knowledge raised issues of fundamental significance, questions which were not resolved in the eighteenth century and which have not been settled since.

The importance of the debate, as it affected science, can be seen in five key areas: 1. Biology; 2. Chemistry; 3. Electricity; 4. Physics; 5. Technology.

1. *Biology*

The importance of the debate in science can be seen most clearly in biology. There the controversy was between the proponents of heredity, who were the preformationists, and the

[27] Rostand, pp.209, 526.

ferment theorists, who were environmentalists. The argument was finally resolved by the brilliant synthesis of Maupertuis[28], which incorporated heredity and environment. That is why Maupertuis is regarded as a pioneer of the modern theory of evolution[29], on which the sciences of biology and geology depend. It is likely that the hereditary element in his synthesis was greater than the emphasis on environmental influence[30]. However, he could not have achieved his synthesis without allowing for both heredity and environment. This gives importance to the debate between the proponents of the two strands, which were eventually integrated.

The historical importance of a theory of evolution was to restore the bridge between the life and the physical sciences[31], which had been temporarily destroyed by the lop-sidedness of the Newtonian synthesis. Evolution makes sense not only as the basic principle of biology and geology, but in physics and astronomy also. In biology and geology, evolution can provide a method which at once allows for, and rationalises, change. This overcomes the disadvantage of the preformationist rationale, which stands for a static system of biology, and an unchanging universe as far as geology is concerned.

An additional advantage of a theory of evolution is that it can set limits to change, and so rule out catastrophism, or permanent revolution, which represents irrationalism in science, and which to that extent applies severe limitations to its development[32]. Evolution provides an equivalent explanation to that achieved in physics when Newton's laws were devised, as they rationalise

[28] for the importance of Maupertuis, see H. Brown, 'Maupertuis philosophe', *Studies* (1963), xxiv.259-269, and M. L. Dufrenoy, 'Maupertuis et le progrès scientifique', *Studies* (1963), xxv.519-587.

[29] Glass, pp.60-73, regards Maupertuis as 'One of the greatest luminaries of eighteenth-century science'.

[30] R. Hooykaas, *The Principle of uniformity in geology, biology and theology*, p.1.

[31] Hooykaas, 'The Parallel between the history of the earth and the history of the animal world', *Annals of science* (1957), xxx.3-18.

[32] Hooykaas, *The Principle of uniformity*, p.3.

change in terms of time and space. Newton's laws thereby allow for change, but at the same time set limits to it, thus eliminating irrationalism from the physical sciences.

2. *Chemistry*

The achievement of Maupertuis was to synthesise two traditions, one of which emphasised heredity, the other environment, and so to pioneer the modern theory of evolution. This achievement was paralleled in chemistry by Lavoisier[33], who drew on two traditions to formulate the basis of modern chemistry.

Phlogiston theory[34], as pioneered by Stahl, which was orthodox before Lavoisier, stood for the extension of mechanism into chemistry. Lavoisier's contribution was to destroy phlogiston theory and to formulate the modern concept of combustion, which depends on air, on which chemistry is based. Those who comment on Lavoisier's achievement have noted that, through his contribution, chemistry took a step forward and developed a greater resemblance to the physical sciences than it had shown before[35]. What is not recognised is that his contribution developed out of the controversy between the upholders of two conflicting theories, namely, phlogiston and ferment theory, and included elements of both.

[33] for Lavoisier's achievement, see H. Guerlac, pp.76-145, and D. McKie, *Antoine Lavoisier*, pp.59-130, and the same author's *The Birth of modern chemistry*, and W. A. Smeaton, 'New light on Lavoisier: the research of the last ten years', *History of science* (1963), ii.51-69.

[34] J. M. Stillman, *The Story of alchemy and early chemistry*, pp.424-460.

[35] *e.g.* 'At the beginning of the eighteenth century it had been argued that the exact laws of physics could not be applied to chemistry. . . . In other words, chemistry had more in common with the biological sciences than with physics. At the end of the century, the distinction between biological and physical sciences remained, but chemistry was now firmly established as one of the physical sciences'; M. Crosland, 'The Development of chemistry in the eighteenth century', *Studies* (1963), xxiv.410.

Ferment, or the life force in matter, was seen by its supporters, and especially by Montesquieu, to be actualised by climate, in particular, by the air. This gave to the air a position of crucial importance, which Lavoisier's science confirmed. The refinement of his theory, the distinction between oxygen and carbon dioxide in air, made possible by Priestley, was, by comparison, a mere afterthought.

Lavoisier believed that his major contribution would be to demonstrate the crucial significance of air in combustion. That is why he wrote it down that air matters most in combustion, and consigned his letter to the secretary of the Académie des sciences to be opened after his death, in case he should not have time to demonstrate the matter conclusively[36]. He did this also for tactical reasons, so that if anyone else established the matter before him, he would be in a position to argue. He wanted to show that he was in the field. In fact, there was little that was original about Lavoisier's claim that air is important in combustion. Most proponents of the life sciences believed it. For example, in 1774 Buffon wrote that 'L'air est le premier aliment du feu' (F.ix.21; *Introduction à l'histoire des minéraux*). The difficulty was to establish the matter against the contrary claims of the mechanists, who emphasised the importance of fire over air in inducing chemical change. What happened next is well known: Lavoisier employed Priestley's discovery of oxygen to establish his own theory of combustion.

Priestley, and others, could not make use of the discovery of oxygen precisely because there was no debate on science in England. Mechanist phlogiston orthodoxy could be extended to accommodate even so awkward a fact as the existence of oxygen[37]. It was only through having alternative hypotheses available that

[36] McKie, *Antoine Lavoisier*, pp.74-84.

[37] 'phlogiston, this preformed principle or substance, which Stahl saw so easily demonstrated, continued to be convincing long after oxygen had been discovered'; E. Farber, 'Variants of preformation theory in the history of chemistry', *Isis* (1963), liv.447.

it became possible for Lavoisier to destroy the orthodox view of the matter.

It was not clear from the beginning that Lavoisier would be in a position to resolve the problem. His early interests centred on the physical sciences. It was the influence on him of Turgot and of Condillac which, working with his own intellectual development, directed his attention to the life sciences and to chemistry. Here his position as farmer-general was of crucial importance, because it brought Lavoisier into contact with Turgot, who converted him to the physiocratic doctrine of dr Quesnay[38], that value derives from the earth. This was the ferment theory of the life sciences, which Lavoisier put into practice both as an experimental farmer[39], and in his science.

Lavoisier acknowledged his debt to Condillac[40], who was discovered by Rousseau (R.xviii.128; *Confessions*) and introduced by him to Diderot, all of whom shared the prejudices of the ferment theorists. They all emphasised the importance of the fact that the senses are influenced by such forces as climate, heat, the air. This represented a different orientation altogether from reliance on reason, or on mathematics, as the way to knowledge.

Lavoisier's first important achievement as a scientist was in geology, to destroy the belief of the water theorists who claimed that matter derives from water, so that the world was once water[41]. This was the view of some mechanists, which was ridiculed by ferment theorists, who believed in the preexistence of matter. Lavoisier demonstrated convincingly that still water produces no matter, and thereby shook belief in orthodoxy in geology. He was then ready to assail equivalent beliefs in chemistry, in which he was so successful that he has rightly come to be regarded as the man who put that science on its modern footing[42].

[38] McKie, *Antoine Lavoisier*, p.164.
[39] *ibid.*, pp.153-163.
[40] *e.g.* A. Lavoisier, *Traité élémentaire de chimie; Œuvres de Lavoisier*, i.1, 15.
[41] McKie, *Antoine Lavoisier*, pp.59-66.
[42] A. N. Whitehead, *Science and the modern world*, p.75.

3. *Electricity*

In the course of the eighteenth century, Franklin's contention that electricity is a single fluid[43] won the French intelligentsia away from the *abbé* Nollet's support of the Cartesian two-fluid theory of effluence and affluence. The importance of this change was that it made possible the measurement of electrical charges, and thus opened the way to the quantification of electricity, which established the basis for the development of the modern science of electricity. Franklin's achievement represented a synthesis which drew on elements from two conflicting scientific traditions. His development of the idea of 'positive' and 'negative' charges of electricity was taken to represent a win for 'attraction', for the principle enunciated by Newton, and for its extension into electricity.

At the same time, Franklin's famous 'sentry-box experiment', which represented a test of his science by reference to lightning, and which set the stage for his invention of the electric conductors still in common use on houses, had more significance than to provide a spectacle for the élite of France[44]. It was intended by Franklin to show a close relationship between electricity and lightning.

Ferment theorists believed in spontaneous generation, which could be achieved through the forces of nature, the sun, heat, the moon and lightning. If lightning produces life, and if electricity is lightning, then men can produce life. Franklin spent a lot of time both killing animals and in trying to bring them back to life again. Although animals recovered after they were stunned, he did not claim to have achieved regeneration. He was forced to admit that he did not know the exact rôle of electricity in bringing about life, though he was convinced that it played the crucial part: 'The beneficial uses of this electric fluid in the creation we

[43] I. B. Cohen, *Benjamin Franklin*, p.75.

[44] J. R. Torlais, *La Physique expérimentale au XVIII^e siècle*, p.75.

are not yet well acquainted with, though doubtless such there are, and those very considerable'[45].

Franklin felt he was near the solution when he noted of heat, which he considered to be the chief characteristic of living bodies, as cold is of dead ones, that it could be produced either by fermentation or by electricity: 'How many ways there are of kindling fire, or producing heat in bodies! By the sun's rays, by collision, by friction, by hammering, by putrefaction, by fermentation, by mixtures of fluids, by mixtures of solids with fluids, and by electricity'[46]. He noted that fermenting trees attract electricity[47].

Franklin's investigation of the relationship between electricity and life induced him to give extensive courses of shock treatment to patients to restore paralysed limbs. He believed the result to be a success in re-vitalising damaged members: 'The first thing observed, was an immediate greater sensible warmth in the lame limbs that had received the stroke, than in the others. . . . The limbs, too, were found more capable of voluntary motion, and seemed to receive strength'[48].

It is significant in this context that Franklin's *Experiments and observations on electricity made at Philadelphia*, when translated into French, ran into three editions and was 'one of the most widely reprinted scientific books of the mid-eighteenth century'[49]. It was no surprise when, in 1773, Franklin was made one of only eight 'foreign associates' of the Académie des sciences.

The famous 'sentry-box experiment', designed to show the relationship of lightning to electricity, which was important to ferment theorists who believed in spontaneous generation, was

[45] B. Franklin, *Additional papers: opinions and conjectures concerning the properties and effects of the electrical matter, arising from experiments and observations, made at Philadelphia, 1749*, p.214.

[46] B. Franklin to Mr. Kinnersley, 20 February 1762; *Benjamin Franklin's experiments*, ed. by I. B. Cohen, p.371.

[47] B. Franklin to J. Mitchel, 29 April 1749; *op. cit.*, p.210.

[48] B. Franklin to John Pringle, 21 December 1757; *op. cit.*, p.346.

[49] Cohen, *Benjamin Franklin*, p.112.

first performed in France on 10 May 1752 by Dalibard. The choice was no coincidence: it was he who had translated Franklin's book into French at the request of Buffon. Louis XV was so fascinated by Franklin's book that he ordered the kite experiment to be performed at court[50]. So great was the influence of Franklin that, when doubts were raised about Anton Mesmer's use of magnetism and hypnotism, Louis XVI requested that the investigation be conducted by Franklin. As a result of his examination, mesmerism, which was all the rage in Paris, was condemned by Franklin. The Académie des sciences followed up by denouncing Mesmer in 1784. He fled and was forgotten[51].

4. *Physics*

The debate between the mechanists and their foes provided a stimulus for scientific endeavour in physics also. It is against the background of this controversy that the scientific achievement of Alembert and of Lagrange must be seen: 'Problème métaphysique, proposé depuis peu par une des plus célèbres Académies de l'Europe, "si les lois de la statique et de la mécanique sont de vérité nécessaire ou contingente?" . . . Les lois de l'équilibre et du mouvement . . . sont de vérité nécessaire'[52]. His work was aimed at defeating the claims of the proponents of contingency at least as far as mechanics was concerned[53]. Alembert's contribution was

[50] *ibid.*, p.119.

[51] Dulieu, pp.548-549.

[52] J. d'Alembert, *Traité de dynamique*, i.32, 35.

[53] 'd'Alembert framed the following question: is mechanics "de vérité nécessaire ou contingente?"—is its truth necessary or dependent? In other words, can its findings be deduced from evident principles, as are those in mathematics, so that we cannot possibly conceive of their being otherwise, or do they depend on empirical facts which do not appear to us inevitable? In short, is mechanics a branch of mathematics or an empirical science? D'Alembert's reply is an emphatic affirmative in favour of the former': R. J. Forbes and E. J. Dijksterhuis, *A History of science and technology*, ii.326-327.

to extend and establish the mathematics on which, in the last resort, Newton's synthesis depended. 'D'Alembert's principle', set out in his *Traité de dynamique*[54], published in 1743, makes it possible to state mathematically the principles of a system in equilibrium[55]. This was a fundamental requirement for Lagrange's further generalisation and extension of the mathematico-physical world view, which he achieved in his *Mécanique analytique* published in 1788[56].

The trend in physics was away from the geometry of Newton and towards more analytical mathematical techniques which, while they represented an advance on Newton's synthesis, ended by extending and consolidating it[57]. Alembert made a further contribution to this development by procuring for Laplace, who was later to collaborate with Lagrange, appointment to the position of professor of mathematics in the 'Ecole militaire' in Paris[58].

The stimulus needed by Alembert and Lagrange to consolidate Newton's achievement was provided by the critics of the mechanistic science, who here played the rôle of devil's advocate. So Diderot, whose mathematical treatises were aimed at faulting Newton's mathematics[59], and his erstwhile friend, Alembert, were joint editors of the massive *Encyclopédie* until Alembert resigned. Alembert's importance in the Enlightenment is that, in the conflict which developed between the proponents of the physical and the life sciences, he threw his weight behind the former. In England, by comparison, Newton's position was so

[54] J. d'Alembert, *Traité de dynamique*, i.75-78.

[55] R. Grimsley, *Jean d'Alembert (1717-1783)*, p.5.

[56] R. Dugas and P. Costabel, *The Organisation of the principles of classical mechanics*, p.434.

[57] J. Ravetz, 'The Representation of physical quantities in eighteenth-century mathematical physics', *Isis* (1961), lii.7-20.

[58] J. R. Newman, *Laplace*, p.45.

[59] *e.g. Réflexions sur une difficulté proposée contre la manière dont les newtoniens expliquent la cohésion des corps et les autres phénomènes qui s'y rapportent* (A.-T. ix.183-191).

secure and unchallengeable as to stifle debate[60]. Pope reflected much English opinion when he wrote:

> Nature, and Nature's Laws, lay hid in Night.
> God said, 'Let Newton be!' and all was Light[61].

It was the debate within French science, and its absence in England, which worked towards that primacy for science in France in the eighteenth century which England had held in the seventeenth[62].

5. *Technology*

The history of technology is different from the history of the physical sciences[63]. Technology developed from the medieval arts and crafts rather than from the research of intellectuals. Throughout the eighteenth century, the practice was still ahead of the theory[64]. It is only when, as in our own day, the theory precedes the practice, that it becomes possible to marry science and technology.

What was acting as a retarding factor was the resistance of the technologists to measurement, or quantification, which was the characteristic feature of the contemporary mechanical world view[65]. The history of eighteenth-century industries, for example,

[60] 'In England, it was not till a century after his death that men freed themselves from his authority sufficiently to do important original work in the subjects which he had treated'; B. Russell, *A History of western philosophy*, p.521.

[61] A. Pope, 'Epitaph. Intended for Sir Isaac Newton, in Westminster-Abbey', *The Poems of Alexander Pope*, ed. by J. Butt, p.808.

[62] 'However, because of its dogmatic adherence to the letter of Newton's word, the British school lost its vitality in the second half of the century'; R. Taton, *The Rise of analysis: the eighteenth century*, p.397.

[63] A Wolf, *A History of science, technology and philosophy in the eighteenth century*, ii.498-499.

[64] 'Black and Lavoisier are early examples of scientists who showed the basis in theory of industrial inventions that had been arrived at empirically; with Davy and Faraday the balance begins very gradually to tip the other way, towards the scientific advance which precedes and conditions the advances of technology'; T. K. Derry and T. I. Williams, *A Short history of technology*, p.703.

[65] M. Daumas, *Precision of measurement and physical and chemical research in the eighteenth century*, pp.418-430.

dyeing[66], illustrates how slowly a satisfactory relationship came to be established between the consumers of special materials and the production of them in the corresponding industries, and how much subjectivity was allowed to triumph over measurement. While precision mechanics was born in watch-making during the eighteenth century, it did not spread into French industry generally until the next century[67].

In the eighteenth century it transpired that those who proposed the study of the life sciences, who rejected the universalist claims of the mathematicians, also championed technology. This was not a coincidence. They rejected the claim of the mathematical physicists that quantification matters most, and instead favoured a total study of nature, in the tradition of the medieval arts and crafts. So in his *Encyclopédie* of the technology of his time, Diderot emphasised the importance of techniques such as blending and mixing, as much as measurement, as keys to his brand of science, which was essentially physiological, biological, technological and chemical, rather than mathematical.

The advances that occurred in technology during the eighteenth century were brought about by the proponents of the life sciences. Diderot's *Encyclopédie* has rightly been called 'the first comprehensive treatise in technology'[68], and it promoted an interest in the subject. At the same time, the study of meteorology was advanced. Interest in it arose from the emphasis placed in the life sciences on air, and on climate, as vital to life. It was Louis Cotte, who was a friend of Rousseau, who put the study of meteorology on a sound footing in his *Traité de météorologie*. The life scientists' preoccupation with air, and heat, and climate, was further advanced by Réaumur who, after his improvement of the thermometer, organised thermometric observations all over the world between 1733 and 1740. In the same vein, Duhamel studied

[66] J. J. Beer, 'Eighteenth-century theories on the process of dyeing' *Isis* (1960), v.21-31.

[67] Daumas, pp.418, 421, 422, 428.

[68] Derry and Williams, p.285.

the relation of weather to botanical phenomena; and Malorin explored the relationship between weather and disease[69].

In the eighteenth century, technology was not an off-shoot of orthodox science, but was a product of a rejected tradition, ignored by the historians of science, which, paradoxically has made a contribution to the development of science. Because most history of science is written by proponents of the mechanical sciences, or by attractionists, this contribution has been allowed to pass unrecognised.

Contemporaries saw the debate on science as being between Newtonians and Cartesians. For example, Voltaire wrote: 'Les noms de Descartes et de Newton semblent être des mots de ralliement entre deux partis' (Best.1551). This has been a source of confusion to historians ever since. After all, Newton's science represents the fulfilment rather than the overthrow of Descartes's science. Both concentrate on the physical sciences and on a mathematical approach. Even where they differed most, on the question of whether the stratosphere is composed of an ether or is a vacuum, the difference can easily be exaggerated[70]. The debate between Newton and Descartes was at most a controversy within the physical sciences, at least a difference in emphasis, and does not appear to raise any issues of fundamental importance.

To read eighteenth-century French thought as a conflict between French rationalism, as exemplified by Descartes, against English empiricism, as seen in Newton, is false in two respects. The difference between Newton and Descartes cannot properly be so described; and the conflict was not between rationalism and empiricism anyway. Those who upheld the physical sciences, and those who championed the life sciences, shared rationalist and

[69] Wolf, ii.277-280.

[70] 'Explicitly, then, it is for Newton impossible, even in the case of gravitational attractions, to step from the mathematical kind of reasoning to a physical kind of reasoning without introducing the corpuscular hypothesis'; M. Boas and R. Hall, 'Newton's "mechanical principles",' *JHI* (1959), xx.176.

empiricist elements in their thinking to such a degree as to render pointless a distinction along such lines.

How can the contemporary view of a debate between Cartesians and Newtonians be reconciled with the thesis being advanced, namely of a debate between proponents of the physical sciences against upholders of the life sciences? Surely in terms of such a debate, Newton and Descartes would be on the same side, namely, that of the physical sciences?

The likely answer appears to be that the names of Newton and Descartes were slogans in a party war, where the enemy was always dubbed a Cartesian, and Newton was sometimes claimed as an ally. Why did the philosophes disassociate themselves from Descartes? R. R. Palmer gives good reasons for his claim that the Jesuits took over the philosophy of Descartes to assist them in their seventeenth-century conflict with the Jansenists. The result was that: 'In the eighteenth century, the bedrock of Catholic philosophy was the Cartesian dualism categorically affirmed and endlessly reiterated'[71].

A. Vartanian's work supports Palmer's point of view. He has shown (p.39) that the philosophes, who were opposed to what the Catholic church stood for, reacted against the Jesuits' use of the philosophy of Descartes: 'The counterpart of all this was that for the philosophes it became preferable to trace their philosophical or scientific opinions to almost anyone but Descartes: Bacon, Newton, Lucretius, Epicurus, Gassendi'. That is why it proved convenient for each side to label the other as Cartesian.

An additional reason suggests itself. As well as the two-way debate between integrated scientific points of view, one biased towards the physical sciences, the other in favour of the life sciences, there was a debate within each school of thought. In the position identified as that favouring the physical sciences, there was a debate between the preformationists and the upholders of attraction. Those who upheld attraction in biology emphasised

[71] *Catholics and unbelievers*, p.136.

the importance of sex in human and animal generation. They found their champion in Buffon, and other supporters at the Jardin du roi. The 'natural' system of plant classification, pioneered by the Jussieu family at the Jardin, seemed to consolidate this position.

Those who, like Buffon, upheld attraction in biology, classified themselves as Newtonians, and condemned their preformationist foes as Cartesians. Yet many who upheld preformation were in fact supporters of Newtonian science. So Voltaire, foremost amongst the proponents of Newtonian science in eighteenth-century France, was a preformationist who condemned his foes for being Cartesians. Clearly, the use of the names 'Descartes' and 'Newton' in such contexts were merely slogans in a party war, which must not be allowed to confuse the historian: the authority of Newton was being employed to support conflicting positions.

The time has come when it is possible to see the debate in a completely different way, not between Newtonians and Cartesians at all. It was a conflict between the proponents of the life and of the physical sciences, which developed, in the first place, out of the lop-sidedness of the Newtonian synthesis. The advantage of looking at it in this way is that it makes far better sense not only of eighteenth-century science, but of the Enlightenment as well.

At the same time, the debate between the mechanists and the proponents of the life sciences can be interpreted as representing the revival, though in a different form, of the old controversy between the Protestant emphasis on the 'will in bondage' and the Roman Catholic doctrine of free will. The mechanists were the determinists who stood for the negation of individual will: man's duty is to discover and obey pre-ordained laws. Against this, the proponents of the life sciences stood for individual freedom, with man the measure of all things.

If it is taken in this way, it can be seen that each side had its own problems: the mechanists must resolve the issue of evil, while the proponents of the life sciences must face a nihilist dilemma. The problem for the mechanists was: as god made the world in its

present shape, and there is evil in it, is god the author of evil? For the defenders of free will there was a different problem: what if men use their free will to achieve evil ends? If the debate is seen in this way, it becomes clear that the key issues for Enlightenment thinkers were little different from those of the Reformation era.

It is not intended, however, to confine the discussion of the debate to a theological context, but rather to analyse the arguments as they were put forward at the time by the participants. This is history of ideas more than history of theology, and the proponents themselves saw it as a clash of ideologies. Nonetheless, the theological implications of the debate give it additional importance and help to explain why the issues at stake have not been resolved to the satisfaction of all concerned.

In order to give verisimilitude to this interpretation of the Enlightenment, in terms of a controversy between the proponents of the life sciences, on the one hand, and the supporters of a mechanical world view, on the other, it will be useful to determine if this division between the life and the physical sciences in fact existed in French society. It will then be possible to show that the writers of the Enlightenment reflected a division that came about previous to their work.

CHAPTER 2

Science and society

The writers of the Enlightenment were less responsible for creating an interest in science than they were for developing one that already existed. Like the scientists and educated people of the time, they were concerned to resolve problems which mattered to everyone in their own generation, and which still matter today. It was not they who were using science to destroy religion. The *philosophes* were faced with a popular interest in science and with unresolved conflicts within it.

Throughout the eighteenth century, science provided a field of study for the intellectual élite in France. The debate already outlined was their chief concern. The eighteenth century also witnessed the popularisation of science. This had the effect, in the course of the century, of providing an audience for the discussion of the problems of science. These then passed from the minds of the intellectuals to a wider world. The result was that the rift within science, which hitherto concerned only an élite, became, at the next stage, through the popularisation of the subject, a problem for universal concern, to which the philosophes addressed themselves.

The increasing popularity of science in eighteenth-century France needs explanation. Political and social factors played an important rôle. The wars of Louis XIV provided a stimulus to scientific achievement. Siege warfare put a premium on artillery and resulted in a new interest in engineering[1]. This carried through

[1] R. Taton, *L'Ecole royale du génie de Mézières*, p.559.

to peace time, and in 1720 found its fulfilment in the foundation by Louis XV of five schools for engineers within the armed forces[2]. The long period of peace in France after 1714, a result of war weariness, and of the strategy of the balance of powers, provided the necessary precondition for economic advance and for a cultural renaissance in France, not equalled before or since, realised in both the sciences and the arts.

It is a significant fact that the agencies which promoted scientific knowledge in eighteenth-century France worked either for the life sciences or for the physical sciences, but not normally for both. This supports the view that these two strands were thought of differently. The emphasis placed during the seventeenth century on mathematics and the physical sciences was changed in the eighteenth to a far greater support for the life sciences. This happened when it transpired that the life sciences could be disseminated more readily than could the far more complex mathematical physics of Newton, and of those who thought like him.

The most important agent for the promotion of the life sciences was the Jardin du roi[3]. Although it was founded in 1626, the Jardin du roi made no major impact up to about 1718. Until then it was chiefly concerned with the education of doctors and chemists, and far less with the dissemination of the life sciences. This 'medical period' brought the Jardin du roi into conflict with the medical faculty of the university of Paris, which was jealous of competitors; so that the efforts of those in the Jardin du roi were spent in the struggle for survival. The increase in their span of interests, as it came, resulted in a greater impact on the Paris public.

The Jardin du roi achieved its importance in the dissemination of the life sciences because its courses were open to the public, and because there was no charge for attending. Lectures were

[2] R. Hahn, *L'Enseignement scientifique aux écoles militaires et d'artillerie*, p.516.

[3] Y. Laissus, *Le Jardin du roi*, pp.287-341.

held from 5 a.m. in the summer, so that people could attend before going to work. The fact that the lectures were in the vernacular, not in the Latin of the universities, represented a major advance in educational technique, and at the same time added to the impact they made. Furthermore, there was no enrolment procedure, so that people could attend or not as they chose. There were no examinations.

The emphasis in the courses at the Jardin du roi was on practice rather than theory. In the early years, the lectures and demonstrations were conducted in the open which, as regards the lectures in botany, was a great advantage, as it made the task of demonstration much simpler. Later on, when the numbers became too large, the courses were held in a giant amphitheatre, which seated 600 people, and which was nearly always full.

The golden age of the Jardin du roi was when Buffon was intendant there for almost fifty years from 1 August 1739 to his death on 16 April 1788[4]. He not only extended the Jardin du roi, but also built up its collections of all types of natural phenomena. When these changes became known, the result was an increase in attendance at the courses of instruction. It is against this background of a growing public interest in science, at once developed and met by the Jardin du roi, that it becomes possible to understand the crucial importance of the great advances in botany made there, which themselves had the further effect of capturing the attention of a wider public.

In 1716 Sebastien Vailland established the sexual nature of vegetable reproduction, and demonstrated how it functioned[5]. Up to then it was believed that vegetables are neuters. The importance of Vailland's discovery is that he opened the way for the study of botany as a subject in its own right, apart altogether from medicine, to which it had hitherto been subservient. The

[4] Buffon's importance in the Enlightenment is discussed in chapter 7.

[5] Y. Laissus, *Le Jardin du roi*, p.308.

separate study of botany was first introduced at the Jardin du roi. It was taught there without exclusive reference to drugs.

Linnaeus's new system of plant classification had widespread support in eighteenth-century France[6]. It is of interest that it was rejected at the Jardin du roi. One reason was because, although Linnaeus based his system on the sexual characteristics of flowers, he did not support what was still only a theory, namely, that flowers reproduce sexually[7]. Out of deference to the discovery by Vailland of the sexual nature of vegetable reproduction, and because of Buffon's views on generation, the Jardin was committed to the theory of the sexual nature of plant reproduction generally.

The sexuality of plant generation was justified by Buffon and his colleagues as representing the Newtonian principle of attraction, as the gravitational force was known in the eighteenth century, applied to botany. This was condemned by its enemies as being mechanistic, as a revival of the Epicurean 'atoms and chance' explanation of the universe, because the action of the wind, or of insects, was allowed to explain pollination. This point of view was condemned by, for example, Rousseau as being atheistical, because the initiative is taken from god, the author of life, and transferred to 'chance'—to the wind, and to insects.

The Jardin du roi supported Newton's principle of attraction, but only with reference to the life sciences. The mechanical world view proposed by Newton and Descartes with reference to the physical sciences was either rejected completely or at least considered to be of no consequence.

The result of the rejection of the classification system of Linnaeus was a tremendous effort at the Jardin to develop its own system of plant classification. This was realised by Bernard de Jussieu at the Jardin, and developed there by his nephew Antoine

[6] A. de Virville, *Botany: the eighteenth century*, p.554.

[7] *ibid.*, p.557.

Laurent de Jussieu[8]. The 'natural' method of plant classification developed by the de Jussieu family, while it retained Linnaeus's binary system, was an advance on it. It developed during the nineteenth century to being orthodox, which it still is.

The impact of Buffon's early-morning lectures is difficult to assess. Some idea can be gained by reference to the fact that his *Histoire naturelle* was more widely read than any other book written and published in eighteenth-century France[9]. The growing importance attaching to the life sciences in the course of the century, largely a measure of the achievement of Buffon and of the Jardin du roi, was attested by Diderot in his *De l'interprétation de la nature* when he claimed that the fashion had changed from the mathematico-physical sciences to the study of the life sciences (A.-T.i.180).

In eighteenth-century France, the life sciences were closely associated with technology. This was partly for traditional reasons, and also because the synthesis achieved by Newton did not include them. The chief reason for the association was because technology and the life sciences were seen to cater for man's needs, whereas this did not seem to be the case with the physical sciences.

The growth of industry in eighteenth-century France resulted in a renewal of interest in technology. This in turn helped the cause of the proponents of the life sciences. The expansion of the steel industry at Dauphiné, and the paper industry at Angoumois, and glass at Nivernais, and Argonne, and the cotton industry in Alsace, were all part of an industrial recovery after 1713, and all explain a growing interest in technology. One result was seen in an intense interest in the study of mineralogy[10].

[8] A. D. de Virville, *Botany: the eighteenth century*, p.555.

[9] D. Mornet, 'Les Enseignements des bibliothèques privées 1750-1780', *RHL* (1910), xvii.9.

[10] A. Birembaut, *'L'Enseignement de la minéralogie et des techniques minières*, p.367.

An interest in mineralogy was at once heightened and satisfied by the course introduced in the Jardin du roi from 1745. It was supported by the collection of natural history material developed by Buffon. Louis Daubenton (1716-1800), who was Buffon's chief collaborator[11], lectured on mineralogy and set the foundation for a chair in the subject in the 'Bureau of natural history'[12]. His course concerned not only the earth, stones and mining, but inflammable substances, salts, chemistry and inorganic matter too.

The growing interest in mineralogy can be seen in the increasing number of major collections which fully occupied one or more rooms in the houses of the wealthy. There were known to be 17 in 1742, 21 in 1757, and 61 in 1780 in Paris alone[12]. In his *Notices sur Vanloo et Rouelle*, Diderot estimated the number of general collections at 200 (A.-T.vi.408). The article on *Cabinets d'histoire naturelle* in the *Encyclopédie* ran to over 1000 words.

Much the same development can be seen in the institution of a course in mining, which was first taught from 1744 at the Ecole des ponts et chaussées, in courses which were open to the public. Interest in the subject resulted in the formation, in addition, of the Ecole des mines in 1783, to separate the public from the professional course in mining offered by the latter.

The formation in Paris in 1766 of a special school to concentrate on architecture, draftsmanship and art[13], met with outstanding success. The 1500 students who enrolled were divided into three groups, which had to be further split up into four classes of 125 each, as the facilities could only cater for so many. Further, although each group could only meet for two hours twice each week, this kept the building fully occupied from 7 a.m. to 5.30 p.m. on six days of the week. An additional 3500 asked for admission but had to be refused.

[11] J. Rostand, *General biology: the eighteenth century*, p.513.

[12] A. Birembaut, *L'Enseignement de la minéralogie et des techniques minières*, p.367.

[13] *ibid.*, pp.441-476.

A most important reason for a developing interest in the life sciences and in technology was royal patronage, which rendered fashionable what was already an established interest. An indication of Louis XV's interest is provided by the fact that the biggest collection of scientific instruments belonged to the king, and was housed in the Collège royal. The inventory ran to sixteen pages[14]. The king's interest in science was seen in his promotion of this Collège[15], where, by 1770, seven of the nineteenth professorial chairs were devoted to science. The Collège came to be noted for its emphasis on the practical approach. The *abbé* Jean Terrasson, who lectured there between 1721 and 1750, taucht experimental physics by relating his own experiments, and with little or no mathematics. Electricity was taught by the *abbé* Nollet.

Royal influence was important also in the formation in 1751 of the Ecole royale militaire de Paris[16]. This was to educate nobles aged, on entrance, between eight and eleven years, whose parents lacked money. The bias was heavily in favour of applied science.

Louis XV's action in forming in 1748 the Ecole royale du génie de Mézières[17] set the foundation on which the Ecole polytechnique was created during the French revolution. The school was established to provide formal training for engineers, who were seen to be important in siege warfare, which accounts for the king's interest.

Louis XV's patronage extended to individual scientists, and added, in particular, to the impact made by the *abbé* Nollet[18]. Nollet's exhibitions both at court and in Paris made a major impact on public opinion. His extensive travels, and his argument with the American Franklin over the nature of thunder[18],

[14] J. Torlais, *La Physique expérimentale au XVIII^e siècle*, p.633.

[15] J. Torlais, *Le Collège royal*, pp.261-286.

[16] R. Hahn, *L'Enseignement scientifique aux écoles militaires et d'artillerie*, pp.523-531.

[17] R. Taton, *L'Ecole royale du génie de Mézières*, pp.559-615.

[18] J. Torlais, *La Physique expérimentale au XVIII^e siècle*, p.213.

added to his effectiveness as an agent for the diffusion of science. Nollet was accepted far more for his shows and exhibitions than for the theory that lay behind them[19]. It was he who used a Leyden jar to give an electric shock to 180 royal guards, and later to 700 monks holding hands, so that they all jumped into the air simultaneously, to the intense satisfaction of the spectators[20]. It was Nollet who dived into the Seine in 1743 to establish that sound signals can be heard under water, and that their pitch is not altered by the change of medium.

Nollet's strength lay in the emphasis he placed on applied science, what would be called technology today. He started out as an instrument-maker, and made 345 different types, some of which were bought by Voltaire[21]. He concentrated his attention on electricity, which was still in its infancy[22]. Rather than develop the theory of electricity, he strove to discover immediate applications for it. He proposed the use of electricity to cure paralytics. It has rightly been claimed for Nollet that he was a precursor of technical education and of technology[23]. His public courses in Paris in 1734, 1735 and 1738 had a powerful technological bias. They were attended, amongst other notables, by the king of Sardinia, and the *dauphin* of France. He gave a course in 1736 at the home of the marquis de Locmaria[24].

The course in electricity and applied physics inaugurated by Nollet at the Collège de Navarre in 1753 has been taken to represent the recognition of a technological-type of physics as

[19] 'il fit de la physique expérimentale un plaisir d'amateur et un divertissement à la mode'. D. Mornet, *Les Sciences de la nature en France au XVIII^e siècle*, p.87.

[20] G. Canguilhem, *Animal physiology: the eighteenth century*, p.538.

[21] M. de Labriolle, 'Le Pour et contre et son temps', *Studies* (1965), xxxv.517.

[22] 'actually, all discoveries which were to make electricity such an overwhelming force in the world were still to be made by the end of the eighteenth century'. R. J. Forbes & E. J. Dijksterhuis, *A History of science and technology*, ii.436.

[23] J. Torlais, *La Physique expérimentale au XVIII^e siècle*, pp.626, 624.

[24] M. de Labriolle, xxxv.516.

the leading discipline of the day[25]. Certainly, it was expected to make the world a better place in which to live. More specifically, the influence of Nollet can be seen in Alembert's recognition, in his 'Discours' in the *Encyclopédie*, that applied science was as worthy of study as mathematics or physics[26]. This was a striking concession from a mathematical physicist to the applied science of Nollet, who made little or no use of mathematics.

A big weakness in Nollet's science was that it retained elements of Cartesian influence. His theory of simultaneous affluences and effluences in electricity was mechanistic and Cartesian[27]. When Franklin introduced his integrated single-fluid theory, which depended on attraction and repulsion, Nollet's days were numbered. Franklin was seen as the Newton of electricity[28]. Buffon gave him his support. By 1752 it was Delor, not the *abbé* Nollet, who demonstrated electricity to Louis XV and his court. Nollet's removal from Paris to Navarre in 1753 was a form of exile[29]. When, in the same year, Louis XV provided money to build a giant amphitheatre, which seated 600, for the course by Nollet at the Collège de Navarre[30], this was as much for services rendered as for anything the future might hold. Nollet stayed there until his death in 1770. None the less, the future was safe for courses in applied technology-type physics. Other such courses were introduced at Pont-à-Mousson in 1759, Caen in 1762, and Draguignan in 1765, to mention only a few[31], and popularised in many books.

It is of some interest that, in contrast with the life sciences, which were making so great an impact in Paris, it was the

[25] J. Torlais, *La Physique expérimentale au XVIII^e siècle*, p.213.

[26] J. d'Alembert, *Discours préliminaire de l'encyclopédie*, ed. by F. Picaret, p.70.

[27] E. Bauer, *Electricity and magnetism in the eighteenth century*, p.475.

[28] I. B. Cohen, *Benjamin Franklin*, p.115.

[29] I. B. Cohen, 'Introduction' to *Benjamin Franklin's experiments*, pp. 102, 103.

[30] J. Torlais, *La Physique expérimentale au XVIII^e siècle*, p.213.

[31] D. Mornet, *Les Origines intellectuelles*, p.181.

physical sciences that were being taught in the schools. This was bound to result, in the long run, in a clash between these diverging branches of science, or in a developing awareness of difference in orientation, which would pose problems for anyone concerned with the subject. The more people who developed an interest in science, the greater would be the problem.

It now seems likely that insufficient attention has been given to the importance of eighteenth-century French formal school-teaching[32] as a factor in the growth of interest in science. It was a force making for the great achievements of French scientists, which resulted in the pre-eminence won by England in the seventeenth century in the physical sciences, passing to France in the course of the eighteenth. What kind of science was being taught? There was none in the primary schools[33]. The Jesuits, who dominated education in eighteenth-century France[34], along with the Oratorians and the Benedictines, all taught science at the secondary school level.

An examination of all theses produced in Jesuit colleges between 1700 and the dissolution of the Jesuits in 1762 revealed that physics was being taught, together with theology, and that the emphasis in the theses was on Cartesian, and away from Newtonian, physics[35]. This is not surprising. Palmer has shown convincingly that, in their prolonged controversy with the Jansenists, the Jesuits employed the philosophy of Descartes as a weapon with which to fight their foes[36]. The result was a commitment to Descartes which lasted throughout the eighteenth century, which extended into their schools, and was employed to defeat all and sundry alternative systems. The argument of the

[32] *ibid.*, p.319, where the importance of school teaching is discussed.

[33] J. McManners, *French ecclesiastical society under the ancien régime*, p.148.

[34] L. G. Crocker, *The Embattled philosopher*, p.6.

[35] F. de Dainville, *L'Enseignement scientifique dans les collèges des jésuites*, p.29.

[36] R. R. Palmer, *Catholics and unbelievers in eighteenth-century France*, p.136.

theses provided a variation on the theme that the science of Descartes would uphold a belief in god, whereas the science of Newton, because it utilised the atomic argument of the ancients, would result in materialism[37]. This religious motive was found to occupy a central place in the theses presented by students. Nonetheless, the standard achieved in physics was of a good average order.

As the century advanced, the teaching of physics improved. This can be seen through an examination of Jesuit schools[38]. In 1700, physics was taught in 80 out of 88 Jesuit colleges. However, this figure can mislead, because 50 of these schools had only one teacher who taught at all levels, and the remaining 30 also had only one teacher, who taught both physics and logic in alternate years and, once again, at all levels. By 1761, the year before the dissolution of the Jesuit order in France, things had improved dramatically. This at once reflected a growing interest in physics and at the same time improved the teaching of the subject. By 1761, physics was being taught at 85 out of 90 Jesuit colleges, and 62 had a full-time course, compared with only 23 where the course was being offered in alternate years. At the beginning of the century, the method of presentation of the courses was far more like history of science than a science course proper. Various systems were outlined and examined, the science of Aristotle being followed by that of Copernicus, Gassendi, Tycho Brahe, Galilei, Huygens, Newton and Descartes. From about 1750 onwards, there was a diminution in this line of treatment in favour of a greater emphasis on the respective merits of Descartes and Newton, which underlined the fact of a commitment to Descartes[39].

The Jesuits had their schools in the cities and towns. The Oratorians[40] and the Benedictines[41], in order to avoid competition

[37] F. de Dainville, p.48.

[38] *ibid.*, *L'Enseignement scientifique dans les collèges de jésuites*, pp.27-65.

[39] *ibid.*, pp.43-48.

[40] P. Costabel, *L'Oratoire de France et ses collèges*, pp.67-100.

[41] R. Lemoine, *L'Enseignement scientifique dans les collèges bénédictins*, pp.101-123.

from them, had theirs in the country. The Oratorians were next in importance to the Jesuits, having by 1788 a total of 35 colleges in France. Far less is known about their courses of study than has been discovered as regards the Jesuit schools. The fact that many of the Oratorians were eminent as scientists indicates that there was an emphasis on the teaching of the subject. Their aim was to complement in the country the education the Jesuits offered to city dwellers. They were influenced by the Jesuit emphasis on physics to introduce courses into their own colleges.

The centre of gravity of the French educational system was in the schools, not in the universities, which were bound down by traditional rivalries and medieval syllabuses. The schools offered six years of humanities, followed by two years of philosophy, the last two years representing what is now done in the first years of a university course[42]. It was in the last two years at school that science was introduced, and came, as the century advanced, to play an increasingly important part.

Between 1763 and 1766, many colleges were affiliated, under varying conditions, with the closest university, so that degrees could be given. In this way it became possible to obtain a degree which should have at least 20 per cent of it devoted to science. So, for example, by 1762, when the Jesuits were expelled by royal decree from France, the last two years of the school course normally comprised logic, metaphysics, morals, mathematics and physics[43]. The link-up with the universities, though it made it possible to obtain a degree with a science content, was a disadvantage in other ways, as the universities were extremely backward. By comparison with the schools, the universities offered little in the way of science. A result was that the advances made by French scientists in the eighteenth century were not achieved in the universities. Furthermore, the discussion of science, and its impact on society, and the attempt to resolve the problems of

[42] P. Costabel, p.21.

[43] *ibid.*, pp.21-22.

science, was the work of literati, the philosophes, who had little or no connection with the universities.

Just as French kings were failing to adjust monarchy to the changing needs of French society, the universities too were looking to the past rather than to their future[44]. Their chief concern was with theology, not science. For the most part, the academics were mere upholders of existing institutions, or else reactionary in their points of view. It is no accident that the university of Paris was suppressed, along with the monarchy, in the French revolution. It was no more than justice, for the university had failed at least as much as the king. By 1789, there were twenty-two universities in France[45]. Much of their effort was spent in conflict with one another over their respective zones of influence.

The most influential of them was the university of Paris, which provided a model for them all. There were four faculties in the university of Paris: theology, law, medicine and arts. Passage through arts was a prerequisite for entry to the other faculties. It is difficult to generalise about the lectures, because they varied in quality and approach. This variation was largely because lectures were conducted in about forty colleges all over Paris, there being no one central meeting place. Notwithstanding, they all had certain common features. All teaching was in Latin; and the physics taught was essentially Aristotelian. Even when, as the century advanced, some Cartesian and Newtonian science was introduced, this did not change the emphasis of the courses.

There was tremendous competition between the Jesuit colleges, situated, like the universities, in the chief cities and towns of France, and the universities. The conflict between the Jesuit educational system and the university of Paris dominated the history of the university[46], which was also something of a denominational controversy, as the teachers in the universities were, for

[44] mlle Lacoarret and mme Ter-Menassian, *Les Universités au XVIII^e siècle*, pp.125-168.

[45] *ibid.*, p.126.

[46] 'en fait, la lutte qui les oppose à l'Université de Paris domine l'histoire de cette dernière'; *ibid.*, p.133.

the most part, clerics, and not Jesuits. A result of the controversy with the Jesuits was that in the debate between Newton and Descartes, while rejecting both, the university of Paris favoured Newton's science more than that of Descartes. In this vein, the *abbé* Sigorgne introduced a course of Newtonian science into the Collège d'Harcourt in 1740. Nevertheless, it would be easy to overstate the importance of one such course in a university which showed little or no interest in modern science, and where no important scientific work was undertaken in the course of the century. While the contribution of the schools to the growing interest in science has not been sufficiently appreciated, it is easy to over-state the importance in this respect of the university of Paris, or of any other university in eighteenth-century France. There was much talk of modernising the university of Paris, which is not surprising in an age when reform was a favourite topic. So, for example, Diderot in his *Plan d'une université pour le gouvernement de Russie* (A.-T.iii.409-534), and Helvétius in *De l'homme*[47] proposed changes. But all the talk had little or no result as far as the university was concerned.

The increasing incapacity of the universities to fulfil their educational function can be seen in the teaching of medicine[48]. Whereas in 1700 there were in France 22 faculties in universities, and 22 colleges, devoted to medicine, by 1793 there were only 16 faculties in existence, and only five of them were active. A further five were still functioning, though in a very limited way, while the rest were nominally alive, but not operating. In 1786 the university of Paris could not distribute its prizes in medicine as there were not enough candidates. This decline in the universities, which affected all the faculties more or less, was due in large part to lack of royal support, because this resulted in lack of funds. Louis XV opposed the Jansenism of the universities, which aligned them with the parliamentary opposition to him. The king

[47] I. Cummings, *Helvétius*, pp.159-174.

[48] P. Huard, *L'Enseignement médico-chirurgical au XVIII^e siècle*, pp.171-257.

was interested in medicine and in botany, but he found other outlets than the university of Paris for these hobbies. He favoured the Société royale de médecine[49], which operated in opposition to the university. His interest in botany found fulfilment in the botanical gardens at Trianon and in the Jardin du roi.

The growing popularity of the life sciences was reflected nowhere better than in the Académie des sciences where, in the course of the century, interest in the life sciences came to predominate. It all began as a debate about whether or not the newfangled Newtonian mechanics should be preferred to the Cartesian world view. Up to 1738, most of the members favoured Cartesian as against Newtonian physics[50]. The members of the Académie, disbelieving, amongst other things, Newton's predictions about the shape of the earth, sent out teams to test his work. In May 1735, Bouger, Godin, La Condamine and others, were sent to Peru to measure the meridian arc[51]. They were away eight years. In the same vein, Maupertuis and La Condamine were sent to Lapland for a year[52]. The outcome of this mission was to prove that there is a flattening at the pole, as Newton had predicted. Though a great many continued to reject Newton's science, it became increasingly difficult to do so as these findings came to hand.

Once having displaced Cartesian physics, the way was open for an assault on other aspects of his science. It was often in the name of Newton that new assaults were made on Cartesian orthodoxy. As well as that, the growing interest in the life sciences, and in technology, could not be gainsayed by the Académie. Whereas in 1748 the topic for their prize essay was on the theory of the movements of Jupiter and Saturn, by 1781 the

[49] *ibid.*, p.210.

[50] P. Brunet, *L'Introduction des théories de Newton en France au XVIII^e siècle: avant 1738*, pp.10-46.

[51] J. Levy, *The Solar system*, p.450.

[52] M. R. de Labriolle, 'Le Pour et contre et son temps', xxxv.510.

Académie chose the subject of the laws of friction and the stiffness of ropes for its competition[53].

The termination of the Jesuit order in 1762 is a topic which falls outside the scope of this study. The part played by their persistent support of the physical sciences, in the name of Descartes, while in Paris society, under royal patronage, the life sciences were gaining ground, is something which needs to be examined. It would be a mistake to see all the *philosophes* in Paris as upholders of the life sciences against the physical sciences of the orthodox. Professor Mornet has shown that many orthodox believers were proponents of the life sciences[54]; and many of the *philosophes*, such as, for example, Voltaire and Alembert, were supporters of the physical sciences. The division between the proponents of the life sciences and the supporters of the physical sciences cut across religious lines. None the less, as the century advanced, as the life sciences gained support amongst the intelligentsia in Paris, a cleavage became apparent between the orthodoxy of the country[55], seen especially in the Jesuits' continued emphasis on the physical sciences, compared with the new popularity of the life sciences in Paris. While the split within science resulted in the first place from an imbalance in the inheritance from the previous century, it was made use of to settle old scores. The Jesuits were amongst the casualties in the war of ideas.

[53] R. Dugas and P. Costabel, *Classical mechanics: the eighteenth century*, p.446.

[54] D. Mornet, *Les Origines intellectuelles*, p.148.

[55] J. McManners, *French ecclesiastical society under the ancien régime*, p.214.

CHAPTER 3

Science and the doctrine of god

Did the deism, the atheism and the agnosticism of the Enlightenment derive from the views on science of the *philosophes*? It is now a matter of common knowledge that this was not the position: 'Bref, il est certain que les savants de la nouvelle école n'ont pas inventé la philosophie qui convenait à leur conception de la science, mais qu'ils ont au contraire transporté dans la science des attitudes qu'ils devaient au déisme ou à l'athéisme des philosophes à demi clandestins de la première moitié du siècle'[1].

Why, then, did the *philosophes* concern themselves so much with scientific method? Was this the interest of the scientist, or was it a means to an end? It will now be argued that the second possibility is the appropriate one.

The *philosophes* blamed Christianity for most of the ills of the old régime. That is why they shared a common antipathy to it. Voltaire was not untypical in his condemnation. He spent the last twenty years of his long life at Ferney in a campaign which had as its slogan 'écrasez l'infâme'[2]. There was reason to criticise the Roman Catholic church in eighteenth-century France. That is one reason why the works of the *philosophes* were so widely read. During the seventeenth century, the church had come, to all intents and purposes, under the control of the king. However, this state control became nominal after the reign of Louis XIV, when a series of weak kings resulted in a remarkable degree of autonomy for the church[3]. Controlled neither by king nor pope,

[1] J. Roger, *Les Sciences de la vie dans la pensée française du XVIII^e siècle*, p.751.

[2] P. Gay, *Voltaire's politics*, pp.239-241.

[3] J. McManners, *French ecclesiastical society under the ancien régime*, p.262.

the Catholic church in France lacked purpose, and degenerated. The degeneration of the church was hastened by the habit of giving the higher places as of right to the French nobility[4], who made a career of high living, and so high spending, and as a result developed practices for grasping money wherever possible. Anti-clericalism resulted. It was aimed chiefly at the church hierarchy, and at the taxes exacted by them. Anti-clericalism was expressed through the spoken and the written word. Censorship of the press discouraged but did not prevent criticism. The importance of writers who disseminated through clandestine manuscripts deist and atheist doctrines can scarcely be exaggerated. Wade[5] found 102 of these manuscripts which, due to censorship laws, could not be published, but which were handed around amongst the intelligentsia of the day. These were the original thinkers from whom the *philosophes* gained their ideas, which they published from about 1750 onwards.

Two of the earliest examples of these handwritten reports were *Le Ciel ouvert à tous les hommes* by Pierre Cuppé, and *Le Militaire philosophe*, by anonymous authors. These manuscripts were copied and varied, by addition or otherwise, as they circulated from one admirer to the next, so much so that it is sometimes impossible to discover the author of the original work.

These authors employed the historical method to discredit revelation. Their debt was most of all to Pierre Bayle, who has rightly come to be regarded as a pioneer in the use of the historical method[6]. His aim was not to overthrow religion, but to discover truth. His use of the historical approach[7], which bore fruit in his

[4] such positions as that of a canon were 'very largely a preserve for younger sons of distinguished families'; *ibid.*, p.59.

[5] I. O. Wade, *The Clandestine organisation and diffusion of philosophic ideas*, pp.101-124.

[6] *e.g.* 'It is he who carries out the "Copernican revolution" in the realm of historical science'; E. Cassirer, *The Philosophy of the enlightenment*, p.207.

[7] E. Labrousse, *Pierre Bayle*, ii.3-38.

most famous work, the vastly erudite *Dictionnaire historique et critique*, raised major problems in the historicity of the Christian religion. Bayle's debt was to Descartes[8]. He applied Cartesian scepticism to Christian revelation[9]. The writers of clandestine manuscripts carried Bayle's criticism further than he intended, to question the truth of the Christian religion.

The most typical form of criticism was the euhemerist one[10], which was developed by Bayle, but carried much further by his successors than he himself would have wished. Christianity was likened to earlier religions where heroes were deified by conniving priests to fool credulous people. The doctrine of original sin was rejected as a technique of subjection of people by their priests. Bayle's method of procedure developed not from science, but out of his religious travail. The son of a Calvinist pastor, Bayle defected to Catholicism. Later on, he reverted to Calvinism[11]. His search for religious assurance led him to an astonishingly detailed investigation of the historical roots of Christianity, and to the adoption of a rigorously factual approach[12].

Those who emphasise the crucial importance of Bayle, argue that the method of procedure of the *philosophes* owed more to his historical analytical approach than to science[13]. The *philosophes* continued the tradition initiated by Bayle of applying historical tests to the Christian religion. In the process they raised moral questions which have not been resolved. The method whereby revelation was discredited was to argue from contradictions in the *Bible* to the view that it is not a reliable document. It was not until the nineteenth century that a far more dangerous historical argument was employed, namely, to cast doubt on the reliability of the *Bible* by arguing not so much from contradictions in it, as

[8] P. J. S. Whitmore, *Bayle's criticism of Locke*, pp.81-96.

[9] Labrousse, ii.39-68.

[10] F. E. Manuel, *The Eighteenth century confronts the gods*, pp.85-125.

[11] E. Labrousse, *Pierre Bayle*, i.50-93.

[12] F. E. Manuel, p.25.

[13] *e.g.* L. G. Crocker, *Nature and culture*, p.xi.

to infer from the fact that the gospels were written long after the events they describe, that they could not have been accurate at all.

Certainly, the *philosophes* continued to employ Bayle's historical method. However, a major difference was that in order to establish their position, and to keep their argumentation up-to-date with contemporary fashions, they strengthened their historical approach by reference to science. For example, they claimed that history is a science, in this way winning for history the same standing and validity as was enjoyed by the sciences. As a result, their doubts about the historicity of Christianity were greatly strengthened. In this vein, in his *Remarques pour servir de supplément à l'Essai sur les mœurs*, Voltaire referred to 'la science de l'histoire' (M.xxiv.543). In much the same way, in his *Manière de bien juger dans les ouvrages de peinture*, Diderot referred to 'la science de la géographie et de l'histoire' (A.-T.xiii.99). Rousseau, too, rated history as a science which, at its best, provides men with facts from which they should draw their own conclusions (R.iv.71, 72; *Emile*). The *philosophes* could now claim that not only history, but science, too, was on their side.

In this context, Bayle was seen as a precursor, someone who adopted a rigorously factual approach and who drew his conclusions accordingly. However, he was criticised by Voltaire for his lack of knowledge of science: 'Il ne savait presque rien en physique. Il ignorait les découvertes du grand Newton' (M.xiv.38; *Siècle de Louis XIV*). Voltaire regarded a factual approach as good, but a rigorously scientific method as better. This was a test which Bayle could not withstand. Because Bayle knew little of science, contenting himself with accepting that of Descartes, those who extol his influence normally underestimate the importance of science to the *philosophes*. Although the *philosophes* referred to Bayle, they did not defer to him. Voltaire rated Newton more highly, while Rousseau hoped for recognition from Linnaeus. Notwithstanding their ignorance of science, it is difficult to exaggerate the importance of the clandestine manuscripts as a

major influence on the thought of the Enlightenment. The authors employed Bayle's sceptical approach, borrowed from Descartes, to undermine revelation. These were men who had lost their belief in revelation, and who set down the reasons why. This anti-Christian literature resulted in such productions as the anonymous *Examen de la religion*, and *La Religion chrétienne analysée*, and culminated in the *Examen critique* of Nicolas Fréret, which entitles him to be called a 'pioneer of the Enlightenment'[14].

The Roman Catholic church in France was too divided within to deal with this criticism. A state of spiritual exhaustion had followed the conflict inside the church between the Jesuits and the Jansenists. In the course of that conflict, the Jesuits aligned themselves with the Cartesian philosophy, in an effort to avoid disaster. This had the undesired effect of encouraging the spread among the faithful of the Cartesian philosophy with its deist credo. While the Jesuits and the Jansenists were engaged in their wordy war, the deist philosophy was spreading unnoticed in the unpublished manuscripts written by the supporters of the new beliefs. This supplied the raw material for the work of the *philosophes*.

While the clandestine writings were important in undermining Christian beliefs, the difficulty was to find anything to put in their place. Negative criticism proved easier than did the provision of alternatives. Notwithstanding, the trend of these early writings was towards deism, which was taken to be the lowest common denominator of religion. Accordingly, the first attempt by the *philosophes* who inherited from Bayle, and from the clandestine manuscripts of the first half of the eighteenth century, to resolve the problems so raised, was to argue for a deist religion, for a god who created the world, but against Jesus Christ as being god.

What will be argued here is that there were not one, but two schools of deist thought, which corresponded with two different

[14] R. Shackleton, *Montesquieu*, p.11.

attitudes to science. Science, though not responsible in the first place for the deism of the *philosophes*, had an important bearing on how these views were expressed. In order to gain the benefit of a scientific rationale, changes were made in the form of deist philosophy to be supported.

For a long time now it has been customary to view the thought of the Enlightenment as an integrated whole. The *philosophes* are seen either employing the scientific method to challenge orthodoxy, or else as trying to repair problems raised by their use of the historical method. What has not generally been recognised is that there was a cleavage within the *philosophe* movement itself. This was both a strength and a weakness. The debate that ensued helped to disseminate the views of the protagonists. At the same time, as the issues involved were not resolved, the debate raised questions of fundamental importance to European thought then and since.

In order to establish beyond reasonable doubt the existence of two different deist positions, one seeking its support in the physical sciences, the other in the life sciences, it will be necessary to analyse the thought of Voltaire and of Rousseau as representative of these different positions.

i. Voltaire and science[1]

Although much has been written about Voltaire, little is known of his views on science[2]. It was not the intention of the author of *Eléments de la philosophie de Newton* that there should be this neglect. Voltaire was writing at a time when science was being

[1] this section has been modified from my 'Voltaire and science: a religious interpretation', *The Journal of religious history* (1966), iv.14-27.

[2] R. Pomeau, 'Etat présent des études voltairiennes', *Studies* (1955), i.196, gives an account of the state of the question of Voltaire's science. Only M. S. Libby, *The Attitude of Voltaire to magic and the sciences*, comes really close to discussing Voltaire's science, but from the point of view of Voltaire's magic, or his irrationalism, a diametrically opposite approach to what is to be attempted here.

transformed from its seventeenth-century condition of being the preserve of an intellectual élite to its more general acceptance by educated people. Even though the debate on science was frequently conducted at an advanced level of theory and practice, Voltaire was well able to hold his own with his contemporaries. He was recognised as a leading light amongst the upholders in France of Newtonian physics against the reigning orthodoxy of Cartesian science[3].

What was the relationship between Voltaire's science and his thought on other matters? Attempts to answer the question vary from belittling Voltaire's interest in science to the other extreme of ascribing highly advanced and specialised scientific knowledge to him. In one instance his views on science are taken to have had no effect on his religious attitude, while in the other all his beliefs are derived from the principle that Voltaire applied a scientific type of empiricism to all fields of knowledge. In the first category falls the eminent biographer Lanson[4]. Brailsford went to the other extreme in asserting that Voltaire almost discovered oxygen[5].

By 'science' Voltaire meant physics, astronomy, geology, biology, chemistry and medicine. Voltaire's discussion of each of these sciences clearly indicates that he was using the terms in their modern sense[6]. He discussed together physics, astronomy and mathematics, which he considered to be closely associated. Newton had employed mathematics to relate physics and

[3] F. de Dainville, *L'Enseignement scientifique dans les collèges des jésuites*, pp.29-65, shows the Jesuits supporting Cartesian science against 'newtonianisme ... une philosophie suspecte par son origine d'Outre-Manche et par ses propagateurs français, Voltaire et Maupertuis' (p.48).

[4] G. Lanson, *Voltaire*, p.73: 'Dans l'histoire des sciences, comme dans celle de la métaphysique, Voltaire ne compte pas'.

[5] H. N. Brailsford, *Voltaire*, p.66: 'Voltaire indeed was on the verge of the discovery of oxygen, but just failed to make it'. No reasons are given, no reference quoted, and no evidence for this view has been discovered.

[6] the use of the modern terminology of the sciences was developed towards the end of the seventeenth century and in the eighteenth century; F. Brunot, *Histoire de la langue française des origines à 1900*, xi.14-18, 58-62.

astronomy, so that it was to be expected that in his own work Voltaire would group them together, because he regarded Newton's achievement as definitive.

As far as brute statistics go, it may be of interest that in Voltaire's published works there are 2036 references to science. While these vary in length from one word to a whole page, most of them are short, extending only to a few words. Voltaire's published works run to 18,367 pages, so that on an average he referred to science once every nine pages. This is a highly significant weighting, second only to his references to religion. From this analysis alone it is clear that Voltaire placed a far greater emphasis on science than has been generally recognised.

Voltaire's interest in science, though not confined to any one aspect, was more concerned with scientific explanation than with anything else. It was the seeming indisputability of scientific laws, and the procedure of developing laws from facts, the inductive method, which impressed him, because it appeared to him that it might well be applied not only to physics and astronomy, which had been the achievement of Newton, but in other fields of knowledge also. The most likely explanation of Voltaire's preoccupation with science is that in the cosmic discoveries that arose from physics and astronomy, and in the methods used to discover them, he hoped to find a solution to the religious problem of his own day, which was posed by the increased acceptance of atheism, for which he blamed the influence of the philosophy of Descartes, and which concerned him greatly. Voltaire's interest in science arose essentially from his pre-occupation with the problem of proving the existence of god. Voltaire was a deist[7] who believed that deism is a universal credo, the common denominator of all religions: 'C'est une espèce de secte, sans association, sans culte, sans cérémonies, sans dispute, et sans zèle,

[7] R. Pomeau, *La Religion de Voltaire*. The thesis, developed throughout the whole book, is that 'Il fut déiste "obstinément, chaleureusement, gravement" ' (p.218), that Voltaire rejected the divinity of Christ whilst retaining the idea of a creator who remained in the background to keep things running correctly.

répandue dans l'univers sans avoir été prêchée' (M.xvii.458; *Dictionnaire philosophique*). He proposed deism as a substitute for Christianity, and spent much of his life in its establishment. Voltaire's deism was his most important intellectual belief[8]. Though he did not himself do so, it is possible to make a distinction between his 'positive' or 'constructive' and his 'negative' or 'destructive' deism, between his development of deist beliefs and his attack on challengers. If this is done, it becomes clear that Voltaire employed science in his 'positive' deism, to establish the existence of god.

Voltaire's doubts about religious orthodoxy seem to have received their first impetus from the pious wranglings of his family, from the contrast between the Jansenism of his father and of his brother, Armand, compared with the beliefs of his Jesuit teachers at the Collège Louis-le-grand. Deism was Voltaire's solution to the controversy between Jansenists and Jesuits[9], a solution which was intended to free religion from narrowness and from the restrictions placed on it by the churches of the Christian religions.

Voltaire's deism was greatly expanded and strengthened as a result of his visit to England in 1726[10]. It was the English concern for justice, freedom and toleration which most impressed him[11], which was represented for him by deism, and which found its scientific support in the work of sir Isaac Newton[12], whose science Voltaire employed to prove the existence of god. It is

[8] 'or, d'un bout à l'autre de cette longue vie, Voltaire fut déiste ardemment, agressivement. Pendant quelque soixante années, il a cherché des justifications'. All of Voltaire's work justifies this conclusion of Pomeau's, p.455.

[9] Pomeau's argument, which is slightly different, is that: 'Le déisme voltairien fut d'abord un anti-jansénisme' (p.27) and that Voltaire's Jesuit teachers unwittingly strengthened his deist beliefs, so that: 'Par leur faute peut-être Arouet n'est pas déjà plus chrétien' (p.73).

[10] for a discussion of this question, see H. E. Haxo, 'Pierre Bayle et Voltaire avant les *Lettres philosophiques*', *PMLA* (1931), xlvi.461-497, and L. Foulet, 'Voltaire en Angleterre', *RHL* (1908), xv.119-125.

[11] P. Gay, *Voltaire's politics*, p.41.

[12] H. Kohn, 'France between Britain and Germany', *JHI* (1956), xvii.283.

clear that, in point of time, Voltaire's deism preceded his science: while his first published works, his *Henriade* and *Œdipe*, reflect his deist convictions, few references are made in them to science[13]. Voltaire did not exaggerate when he claimed that there was no early influence from science, that he had ignored it completely: 'J'ai ignoré absolument pendant le quart de ma vie les raisons de tout ce que j'ai vu, entendu et senti' (M.xix.424; *Dictionnaire philosophique*). His interest in science developed later in his career, during the years he spent in England, and in the Cirey period. In the years after his return from England, and in the sixteen years he subsequently spent at Cirey, from 1734 to 1750, Voltaire was enabled to develop his science to act not only as a support for his deism, but, as he came to believe, to provide an objective proof of it. Long before he left Cirey, the amalgamation of Voltaire's deism and Newtonian science was complete.

Voltaire's deist prejudices were strongly re-enforced by his development of what he considered to be a scientific proof of deism. By the same token, his belief in Newtonian science was strengthened by his deist beliefs. Henceforth, for the remainder of his life, his views on science and its relationship to religion changed little if at all. Roger may well claim: 'Mais sa pensée s'était formée aux environs de 1730 et a conservé jusqu'au bout la marque de son temps'[14]. Certainly, there is no difference between the science of the *Eléments de la philosophie de Newton*, first published in 1738, and Voltaire's later science. It can only be concluded that Voltaire did not change his science from 1738 to the day he died.

Whether Voltaire's views on science were chiefly the outcome of a Lockean type of empiricism, or a result of his deist beliefs, is arguable. The weight of the evidence appears to support the

[13] there are no references to science in *Œdipe*, and only six references in the *Henriade*. The 1730 edition of the *Henriade* showed a modification to one of the references to science to make it more precise, showing Voltaire's growing interest in the subject. See R. T. Murdoch, 'Newton and the French muse', *JHI* (1958), xix.323-334.

[14] J. Roger, *Les Sciences de la vie*, p.746.

latter view, and gains from Wade's conclusion that Voltaire's knowledge of science came far more from books than from laboratory work[15]. Certainly, Voltaire was greatly preoccupied with the achievement of Galilei, Gassendi, Lucretius and Epicurus, all of which knowledge came from books; and nearly all of his work in science bears out Wade's contention.

Voltaire's preoccupation with Newton is important in this context. He referred to Newton 512 times in his published works, which was more often than he referred to anyone else. He always referred to Newton the scientist in terms of reverential awe, because he believed that: 'La philosophie de Newton, qui admet et qui prouve la matière finie et le vide, prouve aussi démonstrativement un dieu . . . un catéchiste de paroisse dit à des enfants qu'il y a un dieu; mais Newton le prouve à des sages' (M.xvii.458; *Dictionnaire philosophique*). It was the idea of a proof that preoccupied Voltaire: 'Tous les astres innombrables, placés dans les profondeurs de l'espace, obéissent aux lois mathématiques découvertes et démonstrées par le grand Newton; . . . un catéchiste annonce dieu aux enfants, et . . . Newton le prouve aux sages' (M.xxi.553; *Histoire de Jenni*).

What did Voltaire mean by a Newtonian proof of the existence of god? He believed that the existence of god can be proven by two key arguments, one from a first cause, the other from design. The influence of Newtonian science was apparent in the argument from effect to cause, and in the mechanical analogical argument from the watch to the watchmaker, which occurs frequently in Voltaire's work: 'Je serai toujours persuadé qu'une horloge prouve un horloger, et que l'univers prouve un dieu' (Best.2745). This argument was phrased and re-phrased in prose and in verse (M.x.182; *Les Cabales*):

> L'univers m'embarrasse; et je ne puis songer
> Que cette horloge existe, et n'ait point d'horloger

[15] I. O. Wade, *Voltaire's Micromégas*, p.6. The same author's *Voltaire and madame Du Châtelet*, p.194 further supports this contention.

The argument from a first cause was an adequate proof for most people. For those who wanted to pursue the matter further, there was the proof from design, which he also propounded.

Having, like most of his contemporaries, dismissed the 'earth-the-centre' Aristotelian cosmology as unsound, there were for Voltaire only two possible ways of explaining how the earth moves around the sun; and if it was not going to be one, it would have to be the other. Descartes proposed a universe composed completely of matter, visible or invisible to the eye, which may be described as a corpuscular or 'plenum' theory[16]. Here the motion of the earth is explained in terms of the motion of the sun, transmitted to earth by, as it were, invisible cog-wheels. The rotation of the sun causes the corpuscles in its immediate vicinity to rotate, resulting in vortices, which end up by causing the earth to rotate. Alternatively, Gassendi argued for a universe composed of matter and space, which may be described as an atomic or 'vacuum' theory[17]. As far as Voltaire was concerned, Gassendi's theory, which gave no account of why the world rotates, left the way open to god as the author of the motion of the earth: 'Si la matière gravite, comme cela est démonstrée, elle ne gravite pas de sa nature, ainsi qu'elle est étendue de sa nature; elle a donc reçu de dieu la gravitation' (M.xxii.403; *Eléments de la philosophie de Newton*). For Voltaire the issue of whether or not there is a god centred on whether space is empty, or a plenum composed of tiny particles of matter invisible to the eye.

Voltaire believed that Newton, by showing that the inverse square law of attraction refers to the motion of planets as well as to terrestrial phenomena, had demolished the Cartesian idea of a plenum, because, if the inverse square law is to apply, space must be empty. So by showing that the universe obeys laws which can

[16] for a discussion of corpuscular theories, especially that of Descartes, refer E. J. Dijksterhuis, *The Mechanisation of the world picture*, pp.418-431.

[17] for the influence of Gassendi on Voltaire, see J. S. Spink, *French free-thought from Gassendi to Voltaire*, especially pp.312-324.

be described mathematically, Newton's 'universal law of gravitation'[18] had established the atomic theory of Gassendi[19]. What had been a belief for Gassendi was now a matter of fact: 'Epicure et Lucrèce, dis-je, admirent les atomes et le vide: Gassendi soutint cette doctrine, et Newton la démontra' (M.xvii.476; *Dictionnaire philosophique*).

Voltaire developed two arguments for design. As well as claiming that Newton had established Gassendi's doctrine of atoms and the void, which necessitated a god, Voltaire employed Maupertuis's 'principle of least action' to achieve a second line of proof for a designer. Descartes's explanation of the universe in terms of extension and motion was, to Voltaire's way of thinking, logically adequate. That is how god would have behaved if all he wanted to do was to create the universe. Voltaire also noted that Descartes's explanation of the universe did not require weight as a property of matter. The weakness of the Cartesian universe became apparent, in Voltaire's eyes, when Newton established (Voltaire would add 'empirically') that attraction, or weight, is a property of matter.

Why had god incorporated weight, or gravity, or attraction, into matter, when, in terms of Descartes's logically adequate system, there was no need for him to have done so? It was at this point that Voltaire showed his indebtedness to Maupertuis's 'principle of least action', which requires that, of two explanations of phenomena, the simpler is to be preferred. Applying this principle to the cosmology of the universe, Maupertuis agreed with Descartes that extension and motion are alone enough to explain all the phenomena: 'Mais si la pesanteur étoit une propriété du premier ordre; si elle étoit attachée à la matière, indépendamment des autres propriétés; nous ne verrions pas que son établissement fût nécessaire, parce qu'elle ne le devroit point à la

[18] B. Russell, *History of western philosophy*, pp.520-521.

[19] M. Boas and R. Hall, 'Newton's "mechanical principles" ', *JHI* (1959), xx.167-187.

combinaison d'autres propriétés antérieures'[20]. Maupertuis then showed that the 'facts' do not agree with Descartes's logically satisfactory system. He did this by proceeding to an 'empirical' verification, by reference to Newton, of weight as a property of matter, thus providing the only exception to his own 'principle of least action'. Only god can make and unmake laws of science. So god incorporated weight, or gravity, or attraction, into matter, simply to demonstrate his existence. He need not otherwise have done so. By virtue of his 'universal law of gravitation', Newton had demonstrated the existence of god—at least as far as Maupertuis and Voltaire were concerned.

Voltaire preferred the first argument from design, because it emphasised the atoms-and-the-void theory of physics, the hallmark of mechanist science, to the use of the 'principle of least action', as the latter is compatible with the idea of the preexistence of matter, which Voltaire rejected. While Voltaire and Maupertuis differed in emphasis in their arguments for design, this was, historically, only a stage in a transition to a full-scale conflict between the mechanists, who argued in the name of physics, and the life scientists, who, as the conflict developed, came to reject that discipline as misleading. Characteristic of this change was the fact that Maupertuis devoted himself, more and more, to the study of the life sciences, while Voltaire concentrated on strengthening the mechanist basis of his scientific argumentation.

Voltaire supported Newton against Descartes because he believed that Descartes's theory was likely to result in atheism, while the atomic theory of Gassendi would result in deism: 'Je dis que j'ai connu beaucoup de personnes que le cartésianisme a conduites à n'admettre d'autre dieu que l'immensité des choses, et que je n'ai vu au contraire aucun newtonien qui ne fût théiste dans le sens le plus rigoureux' (M.xxii.404; *Elément de la philosophie de Newton*). It seemed to Voltaire that a logical extension of Descartes's position was to argue from the view that matter has

[20] Maupertuis, *Discours sur les différentes figures des astres*, p.37.

existed from all time[21] to the view that god does not exist, something that, though Descartes opposed it, might well result from his system. By comparison, the atomic theory of Gassendi seemed to Voltaire to work in favour of a god who had created the world to a plan, which was the god of Newton and of Voltaire.

The importance of gravity, or attraction, was not just that it had recently been formalised by Newton, in his 'universal law of gravitation', but that it seemed to Voltaire a property of matter freely given by god. Accordingly, Newton's science not only explained for Voltaire how attraction works in science, but it at the same time exposed the importance of attraction in metaphysics also. That is why the discussion of the physical and the metaphysical status of attraction as a 'property' of matter occupied a key place in Voltaire's *Eléments de la philosophie de Newton*; and this was understood by his contemporaries, and particularly by the Cartesians who attacked it violently[22].

Although he discussed both aspects of attraction in his *Eléments*, it was the scientific side to which he devoted most attention. He had already committed himself on metaphysics in his important *Traité de métaphysique* (M.xx.189-230). The *Eléments*, published four years later, represents the attempt to provide a scientific proof of the arguments advanced in the earlier work, and, at the same time, to fully develop the argument from design, first stated in the *Lettres philosophiques*, as a proof of the existence of god. Voltaire's god was the creator who fashioned the universe. Having set it in motion, he still continued to supervise its performance, to give strength to the generation of nature and to the thinking processes of men[23]. Even though Voltaire supported Newton's ideas on the intervention of god in the universe, thus setting limits to the importance of science, or of the human capacity to 'reason', as a substitute for the direct intervention of

[21] R. Descartes, *Discourse on method*, i.102-106.

[22] M. de Labriolle, 'Le Pour et contre et son temps', xxv.501, commented: 'Les cartésiens passèrent violemment à l'attaque'.

[23] J. Roger, *Les Sciences de la vie*, p.747.

god in human affairs[24], his position here proved to be not, as he hoped, a terminating point, but rather an intermediate stage in the separation of science and religion[25]. This result was not intended by Voltaire, who still saw science as the handmaid of religion.

Voltaire hoped that his 'theism' would be distinguishable from 'deism', the difference being that his god not only created the world, but stayed in the background to keep things running correctly. His hopes were ill-founded, because in his case the difference was too little[26]. The degree of participation in human affairs by Voltaire's god was far closer to the deist belief in non-intervention than to any of the various beliefs of the Christians.

During the years spent by Voltaire at Ferney, from 1758 to 1788, he engaged in a spirited controversy with the atheists of his time, notably with Holbach, and against the Jesuits. What is not appreciated is that this struggle began for Voltaire much earlier[27]. So his *Eléments de la philosophie de Newton*, first published in 1738, was intended as a counterblast at both the Jesuits and the atheists of his own time, the followers of Descartes. Voltaire believed that the Jesuits had taken over the philosophy of Descartes, to their own peril, and that orthodox Cartesians were atheists. He considered that, by showing the fallacy of Descartes's science, he would weaken both.

The anti-Cartesian, anti-atheistic motive for the publication of the *Eléments* can be seen in Voltaire's correspondence, where what emerges most clearly is his belief that attraction, which was the basis of Voltaire's argument from design, was the key issue.

[24] H. Butterfield, *Origins of modern science*, p.13.

[25] J. R. Loy, 'Nature, reason and enlightenment: Voltaire, Rousseau and Diderot', *Studies* (1963), xxvi. 1088.

[26] R. Pomeau, *La Religion de Voltaire*, pp.422-424, 455.

[27] to the extent that this is so, the distinction between Voltaire's 'constructive' or 'positive' deism and his 'destructive', or 'negative' deism, is meaningless, as instead of coming after each other in a time sequence, both were happening at the same time. This would explain why Voltaire did not make the distinction, which is not employed by R. Pomeau in his *La Religion de Voltaire*.

He referred to attraction as: 'Une nouvelle propriété de la matière' (Best.1503). In August 1735 Voltaire set out to answer the question: 'Dieu peut-il communiquer le don de la pensée à la matière comme il lui communique l'attraction et le mouvement?' (Best.871). His discussion of this problem over the years showed a growing conviction that god intentionally and very clearly had demonstrated that he existed by incorporating attraction into matter: 'Je crois que plus on y fera réflexion, plus on sera porté à croire que la pesanteur est, comme le mouvement, un attribut donné de dieu seul à la matière: il ne pouvait pas la créer sans étendue, mais il pouvait la créer sans pesanteur' (Best.1503).

Here Voltaire showed the extent to which his science was influenced both by Maupertuis's 'principle of least action' and by his own metaphysical beliefs, a debt which he was at more pains to conceal in his *Eléments*. This concealment was not only because of his desire to instruct the reading public, and to employ science towards that end[28], but also to avoid any possibility of being censored. So he wrote of the *Eléments*: 'C'est un ouvrage purement physique, où le plus imbécile fanatique et l'hypocrite le plus envenimé ne saurait rien entendre ni rien trouver à redire' (Best.1233). Notwithstanding, the *Eléments* throws important light on Voltaire's religious beliefs.

The way in which Voltaire's views on religion affected his science can be further seen in his published work on geology. Voltaire was concerned to refute the argument, set out in Buffon's *Epoques de la nature*, that the earth took on its irregular surface shapes as a result of erosion by tides. Notwithstanding that Buffon later changed his position[29], Voltaire was concerned to disprove the argument from water and the tides, which seemed to

[28] referring to the *Encyclopédie*, he wrote: 'Ceux qui président à ce grand et important ouvrage doivent traiter au long les articles des arts et des sciences qui instruisent le public, et ceux auxquels ils confient de petits articles de littérature doivent avoir le mérite d'être courts' (M.iv.497; *Dictionnaire philosophique*).

[29] O. Fellows, 'Buffon's place in the Enlightenment', *Studies* (1965), xxxv. 603-629.

him to do less than justice to his deist belief that the world was created in its existing form: 'Toutes les espèces sont demeurées invariablement les mêmes; il serait bien étrange que la graine de millet conservât éternellement sa nature, et que le globe entier variât la sienne' (M.xxiii.219-230; *Dissertation sur les changements arrivés dans notre globe*).

The type of deist views which were being supported, here as elsewhere, by Voltaire's science may be characterised as 'fixiste'[30]: the god who made the world left no room for evolutionary development. To allow for changes in his masterpiece would be an admission of incompetence. This was the most original feature of Voltaire's deism, and may explain why Voltaire's views on science did not change from 1738 to his death. Voltaire rejected the idea that either the deluge, or the motions of the tides, or both, were responsible for encrustations or sedimentations or erosions on a previously smooth world. He set out his objections in his *Dissertation sur les changements arrivés dans notre globe* (M.xxiii.219-230) and in his *Des singularités de la nature*: 'Le grand Etre, qui a formé l'or et le feu, les arbres, l'herbe, l'homme et la fourmi, a fait l'Océan et les montagnes' (M.xxvii.141).

As the position now taken by geologists, that the uneven surface of the world was a by-product of a cooling process[31], had few adherents in early eighteenth-century France[32], it is not surprising that Voltaire did not espouse it. But his arguments against the water theorists, or 'neptunists', as they are sometimes known[33], were no more scientific than were the arguments of those he combatted. The discovery of some shells on top of the Alps, being used to prove one side in the argument, prompted Voltaire to take issue: 'Quand je lus, il y a quarante ans, qu'on avait trouvé dans les Alpes des coquilles de Syrie, je dis, je l'avoue, d'un ton

[30] J. Roger, *Les Sciences de la vie*, p.743.

[31] P. Lake, *Physical geography*, p.221.

[32] R. Rappaport, 'Problems and sources in the history of geology', *History of science* (1964), iii.67.

[33] C. C. Gillispie, *Genesis and geology*, p.43.

un peu goguenard, que ces coquilles avaient été apparemment apportées par des pèlerins qui revenaient de Jérusalem. M. de Buffon m'en reprit très vertement dans sa Théorie de la Terre, pag. 281. Je n'ai pas voulu me brouiller avec lui pour des coquilles; mais je suis demeuré dans mon opinion' (M.xxvi.408; *La Défense de mon oncle*). Clearly, the deist propagandist had won over the man of science in Voltaire.

In biology, there were two major schools of thought about the origin of the individual, namely, those who favoured preformation, and those who rejected it[34]. It seemed to Voltaire that preformation had been scientifically demonstrated by Charles Bonnet, through claims made on his behalf in a paper delivered to the Académie des sciences by Réaumur in 1740[35].

At the same time, it suited Voltaire's deist beliefs to support preformation, because it left the initial initiative to god to design the original germs which contained inside themselves in miniature the preformed embryos: 'Il semble qu'il en faille revenir à l'ancienne opinion que tous les germes furent formés à la fois par la main qui arrangea l'univers; que chaque germe contient en lui tous ceux qui doivent naître de lui; que toute génération n'est qu'un développement; et, soit que les germes des animaux soient contenus dans les mâles ou dans les femelles, il est vraisemblable qu'ils existent dès le commencement des choses, ainsi que la terre, les mers, les éléments, les astres' (M.xxv.156; review of *Discourse concerning government*, 1764). Preformation was eventually displaced by epigenesis, which stands for the procedures whereby the embryo takes its shape from formless, dissociated matter[36]. So Voltaire had chosen the losing side in the argument. This was no surprising mistake, as most of Voltaire's contemporaries were preformationists.

It was Voltaire's erstwhile friend, Maupertuis, now a rival for the brilliant mme Du Châtelet, and for the patronage of king

[34] B. Glass, *The Establishment of modern genetical theory*, pp.521 et seq.

[35] J. Rostand, *General biology: the eighteenth century*, p.519.

[36] B. Glass, pp.521 et seq.

Frederick II of Prussia, and as an interpreter of Newton to the French, with whom he differed in philosophy, and on almost everything else too, who was one of those who pioneered epigenesis. A further reason for the end of this friendship was because Maupertuis, having shifted his interest from physics and astronomy to biology, showed signs, in his *Vénus physique* of falling under the influence of the environmentalists, the proponents of ferment theory. Voltaire allowed his rivalry with Maupertuis to interfere with a proper appreciation of science. Maupertuis's personal ambitions made him distasteful to Voltaire, who openly asserted his views from 1752 (*e.g.* Best 4280) to when he died. The *Histoire du docteur Akakia* (M.xxiii.559-583), Voltaire's brilliant satire which did much to discredit Maupertuis, shows the triumph of the deist propagandist over the man of science in Voltaire[37].

One of the methods tried to disprove preformation, and the fixity of the species, was to establish spontaneous generation, or biogenesis. Voltaire rightly rejected the belief in spontaneous generation. He did so, however, not after extensive laboratory research, but simply by an inference, which happened to be correct, from his own belief in preformation, a theory which was being disproved in his own time by Maupertuis, who undertook extensive laboratory work in the process[38]. Although in 1765 the *abbé* Spallanzani sent a copy of the Italian edition of his *Nouvelles recherches* to Voltaire[39], and Spallanzani had been concerned to provide a scientific disproof of spontaneous generation, Roger rightly claims that Voltaire made very little use of it[40].

His views on medicine show Voltaire less anxious to instruct than in his discussion of other branches of science. Here his satire

[37] for further details, refer C.Fleischauer, 'L'Akakia de Voltaire', *Studies* (1964), xxx.11-39.

[38] B. Glass, pp.72-74.

[39] R. Pomeau, *La Religion de Voltaire*, p.387.

[40] J. Roger, *Les Sciences de la vie*, p.741, claims that Voltaire made only one direct reference to the work of Spallanzani.

triumphed. Although a hypochondriac[41] who availed himself of the services of a doctor when he needed one, Voltaire showed himself very critical of their practices: 'Il est vrai que très long temps sur cent médecins il y a eu quatre-vingt-dix-huit charlatans' (M.xx.56; *Dictionnaire philosophique*). As regards the medicine of his own day, Voltaire believed that nature cures or else the patient dies: 'Ajoutons que leurs médecins ne guérissent pas plus les maladies mortelles, que les nôtres, et que la nature toute seule guérit à la Chine les petites maladies comme ici' (M.xviii.158; *Dictionnaire philosophique*). He did not believe that drugs can improve the human condition, which is pre-ordained by heredity, and not open to betterment by man or doctor.

Voltaire gave no reason to believe that he thought the position might improve in the future. He carried his criticism of medicine so far as to contrive situations so that he might ridicule doctors: 'On envoya jusqu'à Memphis chercher le grand médecin Hermès, qui vint avec un nombreux cortège. Il visita le malade, et déclara qu'il perdrait l'œil; il prédit même le jour, et l'heure, où ce funeste accident devait arriver. "Si c'eût été l'œil droit", dit-il, "je l'aurais guéri; mais les plaies de l'œil gauche sont incurables"... Deux jours après, l'abcès perça de lui-même; Zadig fut guéri parfaitement. Hermès écrivit un livre où il lui prouva qu'il n'avait pas dû guérir. Zadig ne le lut point' (M.xxi.34; *Zadig*). It is easy to be misled by Voltaire's ingratiating style into overlooking the depth of meaning in what he wrote[42]. So, for example, in the quotation from *Zadig*, the doctor's name of Hermes was no chance selection: Hermes was the ancient name for a magician[43].

In contriving these and other similar situations to criticise doctors (*e.g.* M.xviii.347; *Dictionnaire philosophique*), Voltaire was not only setting out his own views and playing on the

[41] R. Pomeau, *La Religion de Voltaire*, p.237. There is much evidence for this view in Voltaire's *Correspondence*, two examples being Best.1477, 1984.

[42] this point is developed by R. Laufer, *Style rococo, style des lumières*, pp.31, 36-37.

[43] M. S. Libby, *The Attitude of Voltaire to magic and the sciences*, p.246.

prejudices of his audience. Here, too, the religious motive mattered; here, too, can be seen an assault on the importance assigned to medicine by, for example, Descartes[44]. Voltaire was critical of Descartes's views on medicine because they opened the way to a belief in human progress which, in Descartes's thinking, was not otherwise possible. Voltaire rejected the belief in progress in nature because it clashed with his own view, which his science confirmed, that things stay the same. Progress occurs in man's knowledge of nature which itself remains unchanged.

As well as his discussions of the individual sciences, Voltaire frequently referred to science in a general way, both to contrast it with other studies, and to propose science as a model for history[45]. When in his *Remarques pour servir de supplément à l'Essai sur les mœurs* he referred to 'la science de l'histoire' (M.xxiv.543), what he intended was the application of the scientific method to history. Voltaire saw himself as an empiricist. History provided him with an excellent field of study to demonstrate the use of his empirical approach[46], because 'l'histoire est le récit des faits' (M.xix.346; *Dictionnaire philosophique*).

History suited Voltaire's purpose not only by demonstrating the use of the empirical factual approach, but, conversely, by showing the uselessness of 'systems', of the deductive method of Descartes, and of all deductive methods. Criticism of rationalist analyses was a favourite topic not only for Voltaire, but for all the philosophes, especially Condillac, whose *Traité des systèmes* (B.i.1-314) had summarized many of the difficulties associated with a deductive approach, and had opened the way for a new orthodoxy. Voltaire praised Condillac (M.xviii.177; *Dictionnaire philosophique*), and insisted about his own work, compared with what went before: 'On a fait une histoire, et non des systèmes'

[44] A. Vartanian, *Diderot and Descartes*, p.18.

[45] J. Rosenthal, 'Voltaire's philosophy of history', *JHI* (1935), xvi. 151-178.

[46] J. B. Black, *The Art of history*, p.51.

(M.viii.469; *Pièces relatives à l'Essai sur les mœurs*). The model for the historian was provided by the physics of Newton: 'Peut-être arrivera-t-il bientôt dans la manière d'écrire l'histoire ce qui est arrivé dans la physique. Les nouvelles découvertes ont fait proscrire les anciens systèmes. On voudra connaître le genre humain dans ce détail intéressant qui fait aujourd'hui la base de la philosophie naturelle' (M.viii.255; *Fragment sur l'histoire générale*).

Voltaire's emphasis on Newtonian science as the model for the historian shows how important a rôle science played in his outlook. Admittedly, the influence of Voltaire's deist beliefs is predominant not only in his interpretations of each of the different branches of science, but in his history too: 'For the details he gives are not those of the arts and sciences, of customs and industry and commerce, but only those which further the aims of the deist propagandist. . . . The propagandist has got the better of the historian'[47]. Voltaire's deist views predominated over his treatment of history as a science. But for all that, Voltaire's history, like his science, represents a remarkable achievement in overall conception and execution.

The most important impression gained from a detailed examination of Voltaire's published views on science is of a persistent preoccupation with religious beliefs, which constantly intruded into his science. So, for example, in *Micromégas*, the assumption is made that there exists a plurality of inhabited worlds[48]. Wade concluded that this view of Voltaire's reflected the influence on him at once of Huygens and of many other scientists before him, as well as the influence of the works of Fontenelle, and conformed also to a deistic conception of the universe[49] because, Wade

[47] J. H. Brumfitt, *Voltaire historian*, p.94. Brumfitt has established his claim beyond any reasonable doubt.

[48] for a discussion of this idea and its importance, see A. O. Lovejoy, *The Great chain of being*, p.102. It was intended seriously by Voltaire, who was in good company in his own day in believing in a plurality of inhabited worlds.

[49] I. O. Wade, *Voltaire's Micromégas*, pp.50, 42-49, 60.

argued, a plurality of inhabited worlds allows for a relativism in morality which suited Voltaire's deist beliefs[50].

Science was employed, though to a far less degree, in ways other than to prove the existence of god. So, for example, it was employed in an attempt to define the limits of determinism, which is important in the assessment of human responsibility, and because the question has religious significance. For Voltaire, the universe of science is determined; the rest is the sphere of chance. The problem was to demarcate the limits of the universe of science[51]. This in turn raised the question of evil, which must exist outside of science, as science is controlled by god. However, the discussion of such topics as Voltaire's ethics, and his views on evil, raise issues which are still controverted[52], and, as they have little to do with his science, are not relevant to this study. But however Voltaire employed his science, it was not this which was forcing on him his religious beliefs: rather he was using science to prove and to support beliefs reached by other means.

As a by-product of his use of science to prove the existence of god, Voltaire always had in mind the importance of science for instruction, to reduce ignorance. As a populariser of science, Voltaire continued a tradition introduced by Fontenelle[53] of forging a link between science and literature, of writing about science in a manner comprehensible to non-scientists, a trend which has continued from that time.

[50] deism stands for the rejection of Christ's, or anyone else's, claims to be God, so that ethical notions cannot then be justified by reference to any such authority. This opens the way for the use of 'reason' to resolve the important problems.

[51] L. G. Crocker, 'Voltaire's struggle for humanism', *Studies* (1957), iv.147.

[52] for a recent discussion of this problem, refer J. McManners, 'Paul Hazard and the "crisis of the European conscience" ', *Arts* (1962), i.73-86.

[53] this was not Voltaire's only debt to Fontenelle, which he freely acknowledged, referring to: 'M. de Fontenelle, dans ses Eloges des Académiciens, livre plein d'esprit et de raison, et qui rend les sciences respectables' (M.xxii. 376; *Le Préservatif*). This influence, though outside our present purpose, was assessed by R. Maigron, 'L'Influence de Fontenelle', *RHL* (1906), xiii.193-217

'Reason' and 'science' stood for complementary ideas in Voltaire's outlook. 'Science' represented the concern for the particular, for facts, and for the rejection of guesswork. 'Reason' stood for generalisations based on facts, or for inferences drawn from facts[54]. Accordingly, his deist beliefs seemed to Voltaire to arise out of the facts of science. While it is here argued that Voltaire's deism was chronologically prior to his thoughts about science, and logically prior, in that his deism determined his scientific views, it is nonetheless true that Voltaire's use of science to prove the existence of god resulted in a hardening in his deist beliefs.

Voltaire employed science to justify his belief in religious freedom and justice[55], or, as he saw it, his belief in deism. As his deism lost ground, and as science correspondingly gained in popularity, Voltaire became understandably concerned. Science seemed to him to be tending towards an atheism of which he did not approve[56]. His uneasiness about science resulted in a declining interest in it from about 1746 on[57], which is obvious from his correspondence (*e.g.* Best.6937), though in his published works the only sign of it was that he did not add new scientific information to what he published after that date[58]. Even had he wished to discuss science in his correspondence after he left Cirey, he would have been limited by the fact that his amanuensis, Wagnière, knew no science[59].

Science, which Voltaire had hoped to harness for his own religious ends, had, with the failure of his deist credo, passed

[54] E. Cassirer, *The Philosophy of the Enlightenment*, p.8.

[55] Th. Besterman, 'Voltaire', *Studies* (1955), i.15-18.

[56] J. Roger, *Les Sciences de la vie*, p.740, sets 1765 as the date for this conviction of Voltaire's that the atheists were after all winning as regards science.

[57] 'après 1746, Voltaire abandonne la science'; J. Roger, p.737.

[58] investigations by R. Naves revealed that, whereas 25 per cent of the books Voltaire read during the Cirey period were about science, this percentage declined to an average of 6 per cent during the Ferney period; R. Naves, *Le Goût de Voltaire*, p.163. My own investigations support Naves's conclusion.

[59] P. Bonnefon, 'Une Correspondance inédite de Grimm avec Wagnière', *JHL* (1896) iii.481-535.

through the religious restrictions he placed on it. Notwithstanding Voltaire's aim to use it to establish his deist beliefs, the result was not a final synthesis, but was an intermediate stage on the way towards a separation of science and religion[60]. Notwithstanding, Voltaire's achievement in spanning the sciences was remarkable, and succinct, and provides further evidence of his undeniable genius.

ii. Rousseau and science

In strong contrast with Voltaire's use of the physical sciences to under-pin his deist credo, was Rousseau's use, towards the same end, of the life sciences. Commentators on Rousseau have paid little or no attention to his science except to belittle it[1]. It was not the intention of the author of *Dictionnaire des termes d'usage en botanique* (R.xi.169-245) that his science should be taken lightly. To him it was a very serious matter.

The tendency to belittle his science results from the fact that for most of his life Rousseau paid no attention to it (R.xvii.353-356; *Confessions*) until suddenly, when aged 55, he developed a passionate interest in botany at a time when his mind was clearly

[60] J. R. Loy, 'Nature, reason and enlightenment', *Studies* (1963), xxvi. 1088.

[1] for the state of the question of Rousseau studies, refer A. Schinz, *Etat présent des travaux sur J.-J. Rousseau*, pp.3-116, and P. Gay, 'Introduction' to E. Cassirer, *The Question of Jean-Jacques Rousseau*, pp.3-32. For the belittlement of his science, refer, for example, to C. C. Gillispie, *The Encyclopédie and the Jacobin philosophy of science*, p.280: 'His actual writings on nature are surprisingly uninteresting and innocuous.... His botany was a consoling hobby, making no pretence to science'. A. Jansen, *J.-J. Rousseau als botaniker*, is a mere lexicon of Rousseau's botany and no analysis is attempted. Sir G. de Beer, 'Jean-Jacques Rousseau: botanist', *Annals of science* (1954), x.189-223, makes no more claim than to be a translated precis of Jansen's book. The author agrees with Jansen: 'Nobody was further removed from the scientific frame of mind than Rousseau' (p.289).

unstable. His interest in science and his insanity developed on parallel lines to the end of his life. Rousseau commentators take his botany as a symptom of his insanity[2]. This is unfair to Rousseau. His interest in science was not a result of mental instability, but was due to his need to prove the existence of god.

There was a conflict in the thought of Rousseau between his concern for 'bonté' and 'vertu'[3], between man's natural instinct, his 'amour propre', and the common good, 'amour de soi', *Du contrat social* (R.vi.3-206) can be seen as an attempt to synthesise these two concepts. The difficulty, recognised by Rousseau[4], was that men might prefer their own to the common good. In order to reconcile man's individual freedom, as set out in the *Discours sur l'inégalité* (R.i.191-375), and the common good, Rousseau considered it essential to have a 'religion of state', or a civil religion, which could only be justified by the fact of the existence of god[5]. In Rousseau's eyes the *contrat social* required, if it was to be effective, that god not only exist, but that he be proven to exist[6]. The *Profession de foi du vicaire savoyard* (R.iv.136-254) represents Rousseau's attempt to prove the existence of god, and he employed science to do so. From when he wrote the *contrat social* to the end of his life, Rousseau was concerned with science as a means to an end.

[2] D. Mornet, *Rousseau*, p.155, notes that in 1772 Rousseau began 'à courir la campagne pour herboriser et pour rêver' and that in 1776 he went insane. J. Starobinski, *Jean-Jacques Rousseau*, p.292, considered Rousseau's botany as the therapy of a sick man: 'Rousseau trouve dans la botanique un apaisement'. Refer also P. M. Masson's definitive *La Religion de J.-J. Rousseau*, ii.225: 'Dans les dernières années, la musique et la botanique qui ont été les deux "consolations des misères de sa vie" n'étaient plus pour lui œuvre d'artiste ou enquête de savant, mais les simples distractions d'une fantaisie contemplative'.

[3] A. Schinz, *La Pensée de Jean-Jacques Rousseau*, pp.135-157, 159-196; P. Burgelin, *La Philosophie de l'existence de J.-J. Rousseau*, pp.305-348.

[4] A. Schinz, p.357.

[5] the importance of Rousseau's theism to uphold a system of ethics is rightly stressed by L. G. Crocker, *An Age of crisis*, p.34.

[6] C. W. Hendel, *Jean-Jacques Rousseau*, p.124.

The use of science to prove the existence of god was general deist practice[7]. Where Rousseau was original was in the type of scientific proof he advanced. He was at the same time protesting against currently accepted deist proofs and advancing his own alternatives.

Rousseau strongly opposed the use of Newtonian science to prove the existence of god, because he thought that this line of reasoning must logically lead to atheism. That is why he castigated Voltaire, who was foremost amongst those who defended their deism by reference to Newton's science. Rousseau charged Voltaire with being an enemy of god, a claim which has been repeated often since: 'Voltaire, en paroissant toujours croire en Dieu, n'a réellement jamais cru qu'au diable' (R.xviii.276; *Confessions*). Notwithstanding Rousseau's claim, Newtonian science is compatible with a belief in the existence of god, something which Newton himself believed[8]. However, if Newton's three laws of motion are taken to be empirically verifiable, and if, by analogy, only such reasoning as is empirically verifiable is accepted as true, then agnosticism or atheism must follow, for god's existence cannot be demonstrated empirically. If Rousseau had argued along lines such as these, he would have demolished Voltaire's use of Newton's science to prove the existence of god, and would have gone a long way towards substantiating his own claim of an analogical relationship between science and atheism. However, he did not query Voltaire's type of reasoning: he only rejected his use of the physical sciences.

Instead, Rousseau advanced his own brand of rationalist science to defeat that of Voltaire. The most striking feature of Rousseau's science is its powerfully rationalist bias, which contrasts strangely with his own belief that it was empirically based. As this confusion lies at the root of all Enlightenment science, it needs to be carefully examined.

[7] P. M. Masson, *La Religion de J.-J. Rousseau*, i.259.

[8] E. W. Strong, 'Newton and God', *JHI* (1952), xiii.149.

Against Voltaire's postulate of an unchanging universe, which obeys Newton's 'universal law of gravitation', Rousseau postulated a universe that is in a constant state of flux: 'Tout est dans un flux continuel sur la terre. Rien n'y garde une forme constante et arrêtée' (R.xxi.229; *Rêveries*). To Rousseau, this was no postulate, but a matter of fact. If things seem to remain the same, this is because the life of a man is so short that he is not aware of changes that take a long time to happen. Most of the fundamental and obvious changes were made in the past by god, through revolutions. As man develops his capacities, god plays an increasingly less obvious rôle in human affairs: 'Avant que les hommes réunis missent par leurs travaux communs une balance entre ses productions, il falloit, pour qu'elles subsistassent toutes, que la nature se chargeât seule de l'équilibre que la main des hommes conserve aujourd'hui; elle maintenoit . . . cet équilibre par des révolutions' (R.i.521; *Essai sur l'origine des langages*). God still makes changes, the difference being that men can observe them only in retrospect.

Rousseau believed that, because nature is changing so quickly, it is impossible to develop a science for it. He was aware that, by integrating the Aristotelian earth-central cosmology with religion, Christianity had received a tremendous setback when its cosmology was seen to be inappropriate. In consequence, he did not support the deist integration of Newton's heliocentric cosmology with religion, as, when the Newtonian synthesis was shown to be inappropriate, which must happen, deism would seem to be disproven. More specifically, Rousseau rejected the postulates on which Newtonian science is founded, namely, absolute space and absolute time. As there is matter everywhere, there can be no such thing as 'space'. As regards time, he adopted the nominalist position that no two minutes are the same. So, for example, in fifteen minutes, on a walk to visit Diderot, who was a prisoner at Vincennes, Rousseau claimed to have experienced more than in the whole of his life hitherto.

It was from the life sciences, not the physical sciences, that Rousseau hoped to establish the existence of god[9]. God shows his existence as the author of life. His botany was aimed at putting the matter beyond dispute. Rousseau did not accept current preformationist orthodoxy, the belief in god as the author of the original germs from which all later generations derive (*e.g.* R.xi.215, 232; *Dictionnaire*). He rejected this because it made for a belief in each generation following on in an assembly-line type of procedure from the previous one, in a continuous, mechanical, cause-and-effect relationship. The current mechanist orthodoxy of preformation was incongruous with a principle of drastic change, which Rousseau espoused. To the preformationist, little change is possible in the preformed germ: heredity, not environment, is the guiding principle. To Rousseau, the environment is everything, and its basic law is change.

The emphasis by Rousseau, and by like-minded thinkers, on the environment, against current preformationist orthodoxy, where the stress was exclusively on heredity, opened the way to the possibility of a synthesis of heredity and environment. Here antipathy to the mechanical world view opened the way to scientific change, in which the contribution of Rousseau, and of others who thought like him, should not be discounted. Having rejected preformation, Rousseau might well have arrived at the modern theory of epigenesis, as did Maupertuis, his contemporary. However, Rousseau was prevented by his preoccupation with proving the existence of god, which dominated his interest in the study of science. Rousseau explained life not in terms of preformation, but as a 'ferment' which comes from matter. In its traditional form, a 'ferment' was an invisible vitalist principle which exuded from matter to make for life, both animal

[9] most of Rousseau's references to science were to the life sciences. The text of Rousseau's works runs to 8,390 pages. References to science vary between one word and a page, most running to two or three lines. As Rousseau referred to science in all 852 times, this amounts to at least one mention every ten pages. He discussed botany more than any other science, with a total of 329 references.

and vegetable, in an otherwise lifeless universe, and to thus provide evidence for the existence of god.

The ferment theorists, dating back at least to van Helmont[10], and back further, to when fermentation, as in milk, was first noted[11], were re-enforced in the eighteenth century by the teachings of Guillaume François Rouelle, whose course in chemistry was attended by Rousseau (R.xviii.119; *Confessions*). The upholders of ferment against preformation relied on monsters and spontaneous generation to disprove preformation.

Montesquieu, whom Rousseau dubbed 'illustrious' (R.v.249; *Emile*), and who influenced him greatly[12], invented the term 'intussusception'[13] to account for the process whereby fermentation takes place. Rousseau not only shared Montesquieu's belief that life comes from ferment, a god-given property of matter, but he also employed the term 'intussusception' to explain god's ways to man: 'On ne peut disconvenir que les plantes ne soient des corps organisés et vivants, qui se nourrissent et croissent par intussusception, et dont chaque partie possède en elle-même une vitalité isolée et indépendante des autres, puis qu'elles ont la faculté de se reproduire' (R.xi.232; *Dictionnaire*). By Rousseau's time, the belief in ferment was becoming more and more difficult to maintain in proportion as the fact of plant sexuality was coming to be accepted. Camerarius established plant sexuality in 1694[14]. By when Rousseau wrote it could no longer be denied. It was Rousseau's task to reconcile plant sexuality with 'intussusception', and ferment theory.

[10] J. B. Partington, *A History of chemistry*, ii.209-241.

[11] M. Daumas, *The Chemistry of principles*, pp.322-325.

[12] A. Cobban, *Rousseau and the modern state*, p.33: 'Roughly, French political thought in the latter half of the eighteenth century can be divided into two schools—the one formed by the followers of Montesquieu, the other by the rest'. If one accepts the same division for the science of the Enlightenment, there can be no doubt that Rousseau followed Montesquieu.

[13] 'on distingue la vegetation des plantes d'avec celle des pierres et des metaux; on dit que les plantes croissent par intussusception et les pierres par juxtaposition' (N.iii.111; *Essai d'observations*).

[14] A. Davy de Virville, *Botany: the eighteenth century*, p.368.

Rousseau set out to resolve the problem in his *Dictionnaire des termes d'usage en botanique* and in the *Essais élémentaires sur la botanique*, both of which represent a simplified version of the botany of Linnaeus. They played an important rôle in the diffusion of Linnaean botany[15], because whereas Linnaeus wrote in the Latin of the learned, Rousseau's botany was in the vernacular. He wrote in a simple expository style, free from the paradoxes and complexity of his work in politics. He further simplified his botany by presenting it in the form of a dictionary of terms and of letters to a friend. The *Dictionnaire* was original in incorporating, together with a simplified version of Linnaeus's botany, an interpretation of the nature of plant generation. Linnaeus, and those who thought like him, concentrated on classification to the exclusion of all else[16]. Rousseau dismissed as mere 'herborists' (*e.g. Correspondance*, XX.108) those who would not address themselves to the more fundamental question of generation, because the latter has important philosophical implications.

The view on plant generation which Rousseau pioneered was a development from Montesquieu's theory of 'intussusception' to explain life. The reason why variation was needed was to accommodate the very awkward discovery by Camerarius of plant sexuality, with Montesquieu's theory of life by fermentation. Whereas to Montesquieu ferment was an invisible, god-given quality of matter (N.iii.111; *Essai d'observations*), Rousseau actualised the ferment principle in terms of plant sexuality (R.xi.215; *Dictionnaire*). It would appear, at this stage, as if Rousseau had conceded victory to the attractionists who, like Buffon, explained generation in terms of sex. This was not so. Rousseau did not, and could not, go the full way to a theory of sexual generation precisely because he wanted to explain generation in terms of god.

Here was the problem for Rousseau: the ferment theory of life holds good only so long as it is not challenged. If there is no other

[15] *ibid.*, p.559.

[16] J. Von Sachs, *History of botany 1530-1860*, p.82.

explanation, the ferment theorists are vindicated in seeing god as the author of life by ferment. If the reproduction of plants can be adequately explained in terms of their sexuality, then this particular proof of the existence of god is demolished. Rousseau needed either to overcome the claims of the sex theorists, or to move to some other proof of the existence of god. He chose the first alternative. It was in demolishing the claims of the sex theorists that Rousseau felt he had made his major contribution to botany. The capacity of a scientific theory depends on its ability to deal with objections[17]. If Rousseau could despatch the sex theory of generation, then the future was bright for ferment theory.

Rousseau claimed that most plants are hermaphrodites. While they have the capacity to reproduce sexually, by cross fertilisation, they in fact reproduce or not through an internal ferment which is god-controlled. His argument was in two stages. First the claim that plants are hermaphrodites: 'La constitution commune au plus grand nombre de fleurs est d'être hermaphrodites' (R.xi.215; *Dictionnaire*). Rousseau was here stating what is in fact true: most plants are hermaphrodites. So in this sense his science was empirically sound.

The second stage of his argument to establish his theory of ferment was that, as plants have no feet, and so cannot come into contact with each other, their reproduction cannot be by sexual intercourse, but must be through self-pollination as hermaphrodites (R.xi.215; *Dictionnaire*). This seemed to Rousseau to provide an empirical disproof of the importance of sex in generation, and, at the same time, to vindicate ferment theory through hermaphrodite reproduction.

At the time Rousseau was writing, it was still possible to claim that plants are self-pollinating. It was not until the end of the eighteenth century that the argument over plant sexuality was finally resolved: in 1793 K. Sprengel demonstrated that hermaphrodite flowers cannot be self-pollinated because their stamens

[17] T. S. Kuhn, *The Structure of scientific revolutions*, pp.153-158.

and ovules do not mature at the same time. This established the position of G. Kolreuter, and of those who thought like him, that pollination is effected by the wind, or by insects, or through movements of the stamens[18]. Even though the belief in hermaphrodite reproduction seems strange to us now, it was not so against the facts as they were known then. Once plant sexuality was accepted, however, it was, on the face of it, more likely that plant reproduction would be explained that way than as a hermaphrodite performance. Why did Rousseau adopt so unusual a position, one which has brought on him the ridicule of present-day scientists who, of course, know better?

It would have been possible for Rousseau to adopt the position taken by his friend the *abbé* de Saint-Pierre, that what happens in nature is controlled by god, so that, even if plants reproduce sexually, this too has been provided for by god. Rousseau rejected this line of reasoning because it seemed to open the way to atheism, to the Epicurean 'atoms-and-chance' explanation of attractionists who might well be atheists: if the wind pollinates plants, this might well be by chance, and not by god at all. Furthermore, Newton's mechanical science depends on the law of gravitation, which was known as 'attraction', and was taken, by Buffon and others, to stand for sexual attraction in biology. When Saint-Pierre write[19], these objections had not been raised. Rousseau had to fight his battle as things stood in his own time; and, through the Jardin du roi, the attractionists were waxing strong. That is why Rousseau spent the last years of his life in feverish, even tormented, study of botany, looking for signs of the god he knew must exist.

It is instructive to contrast Rousseau's belief that his science was empirically based with the fact of its powerfully rationalist bent, as an example of a basic confusion in much Enlightenment thought between protestations of empiricism and rationalist performance. This has resulted in at least two sorts of confusion. On the one

[18] A. Davy de Virville, pp.558, 559.
[19] V. Buranelli, 'Another look at the philosophes', *JHI* (1957), xviii.475-494.

hand, some analysts have conceded the claims of Enlightenment writers that their views were empirically sound. An alternative result of the confusion has been to dismiss the science of the Enlightenment as unimportant. Neither view is justified.

On the facts available to Rousseau in his time, it was still possible for him to believe that hermaphrodite reproduction by flowers had a powerful empirical basis. But it would be wrong to believe that he arrived at his conclusions in botany after careful botanical investigations. He admitted to little facility in classifying directly from the phenomena (R.xi.95; *Lettres élémentaires sur la botanique*), or in gardening, for that matter: 'Je connois quelque chose à l'ouvrage de la nature mais rien à celui de jardinier' (R.xix.274; *Confessions*). Certainly, Rousseau liked to collect samples, which fitted well with his pleasure in walking (R.xi.163; *Lettres*), and with his love of the country (R.xix.273; *Confessions*); but the samples sometimes putrified without any further action being taken about them (R.xx.281; *Rousseau juge de Jean-Jacques*). Alternatively, Rousseau's efforts to classify proved of no avail, for which he blamed the books on the subject, which were, he believed, written for experts (R.xi.95; *Lettres*). He also blamed his very real difficulty in classifying on the belief that, in order to learn how, there is need for instruction by someone who knows. This was impossible for him while he lived in the country (R.xi.95). Finally, he blamed his eyes: 'J'ai de très mauvais yeux pour analyser les plantes' (R.xi.96; *Lettres*). By the same token, Rousseau believed that he could supply an empirically based or scientific disproof of preformation, which would at the same time establish his alternative of ferment theory, to explain the generation of plant life. Towards this end, he argued that plant reproduction is by shoots, which simply appear near the roots of trees, or plants which grow out of trees, both of which conditions he described as 'drageons' (R.xi.196; *Dictionnaire*); or sticks which simply develop roots of their own, a process known by him as 'bouture' (R.xi.186). However, a far more rigorously empirical approach is needed to resolve the matter.

Notwithstanding, Rousseau made an important contribution to botany by revising its nomenclature so as to indicate its logic and simplicity. However, even though his system was simpler than that of Linnaeus, it was still highly complex, as were all attempts to rationalise botany which were based on the 'artificial' sex system of Linnaeus, compared with the 'natural' families system of Jussieu[20]. The 'natural' system of classification achieved Rousseau's goal of simplification, but by a different means. It is still in use. It is significant that Rousseau rejected the family classification of Jussieu in favour of the 'artificial' system of Linnaeus (R.xi.81; *Lettres*). He did this because the latter blended more easily with his theory of 'intussusception' by allowing, as it were, a male and a female ferment, whereas the family system of Jussieu only further complicated Rousseau's rationalistic science by blurring the lines of causation. Jussieu's system had the further objection for Rousseau that it relied on sexuality to provide the key to plant generation.

Rousseau's rationalism, which found its equivalent in a preoccupation with generation in botany, triumphed over his empiricism, which would have required him to concentrate more on classification. The needs of his rationalistic science blinded him to the superiority of the classification system proposed by de Jussieu compared with that of Linnaeus. The rationalist, religious, non-scientific basis of Rousseau's botany is clear from his argument that he preferred to study botany in the country, not in gardens, nor in the Jardin du roi, because in the country plants grow as god intended, whereas in gardens he was twice removed from god (R.xi.97; *Dictionnaire*). That is why he looked to the time he spent on the île de Saint-Pierre as the happiest in his life: 'De toutes les habitations où j'ai demeuré (et j'en ai eu de charmantes), aucune ne m'a rendu si véritablement heureux et ne m'a laissé de si tendres regrets que l'île de Saint-Pierre' (R.xxi.219; *Rêveries*). It was there that his interest in botany first developed:

[20] A. Davy de Virville, p.558.

'j'étois alors dans ma première ferveur de botanique' (R.xxi.223; *Rêveries*). This was an interest which, notwithstanding brief interludes in cities, remained with him for the rest of his life, and resulted in him living permanently in the country to be near to god and to his beloved plants.

There exists a curious parallel between Rousseau's views on science and his self-image. Rousseau had a strange ailment, which he believed to be unique in the history of mankind, and incurable. To a doctor interested in attempting a cure in 1758, the year in which his interest in botany first developed, he replied: 'Mon mal n'a jamais été connu de personne ... je n'attends ni ne veux plus aucune espèce de soulagement de la part des hommes' (*Correspondance*, iii.323). His ailment, which centred in his reproductive organs, led him to the view that he was specially selected to establish the existence of god by proving that flowers are hermaphrodites. There is difference of opinion as to whether Rousseau's illness was physical or psychic in its origins. If it was physical, it was either a flaw in his genital system, or something like a prostate condition, or both. Although nothing was found to be wrong in a post-mortem examination, it has proven possible for historians to cast doubt on the findings[21]. Throughout, Rousseau saw himself as the high priest of a new theist credo. For many years of his life he wore the robe of an Armenian monk[22], to cater for his ailment, no doubt, but also for religious reasons. On his long walks in the country searching for samples, he always carried a *Bible* with him[23].

Although Rousseau believed that people find their fulfilment through interaction, in society, he lived apart. He saw himself as being different from everyone else. Paradoxically, while he legislated for others to live together, he remained in isolation[24].

[21] R. Grimsley, *Jean-Jacques Rousseau*, p.22.

[22] J. Starobinski, *Jean-Jacques Rousseau*, p.254.

[23] P. M. Masson, *La Religion de J.-J. Rousseau*, ii.245.

[24] F. C. Green, *Jean-Jacques Rousseau*, pp.139-141.

He found his own truth from within, and mirrored it outwards for all to see.

The parallelism between Rousseau's belief in hermaphrodite flowers and his own condition is re-enforced by study of his play *Narcisse*, and its strange hero (R.xi.249-315). Certainly, there are those who doubt that Rousseau had any children by Thérèse Levasseur, that he invented the story of how he put five children of his in the Enfants-trouvés to mislead contemporaries who could find no trace that they ever existed (R.xviii.146-148; *Confessions*). More convincingly, it has been argued that Rousseau was not the father of the Levasseur children: 'un bon nombre de médecins se sont prononcés pour l'impuissance . . . on peut dire que l'abandon des enfants nés en dehors du mariage était la règle'[25]. Unfortunately, the truth may never be discovered.

Rousseau wanted to transcend his sense of selection, to universalise his individual experience. He needed a god to endorse his system. Towards this end, he recognised the need to prove god's existence not only for an intellectual élite, when advanced scientific argumentation can be employed[26]. He also needed a proof for the people, on whose support his religious synthesis depended. He rejected all arguments from mathematical physics or astronomy as being far too complex: 'L'ordre de l'univers, tout admirable qu'il est, ne frappe pas également tous les yeux. Le peuple y fait peu d'attention, manquant des connoissances qui rendent cet ordre sensible' (R.vii.70; *J.-J. Rousseau à Christophe de Beaumont*).

Botany, as simplified by himself, seemed more appropriate to Rousseau than the use of the physical sciences to provide proof of god's existence. Botany had the further advantage for Rousseau that it allowed him to fall back on a second line of argument which was less stringently rational, and so more likely to have general appeal: the argument that the beauty of nature proves the existence of god: 'Je ne trouve point de plus digne hommage à la

[25] A. Schinz, *Etat présent des travaux sur J.-J. Rousseau*, pp.322, 324.

[26] B. Groethuysen, *J.-J. Rousseau*, pp.53, 112.

Divinité que cette admiration muette qu'excite la contemplation de ses œuvres' (R.xix.272; *Confessions*). To the extent that he employed such arguments, Rousseau was using sentiment as well as science, a tacit admission of the limitations of a stringent proof from botany for the purpose he had in mind. Though not appreciated by Rousseau, this was an opening of the way to irrationalism, romanticism, and sentimentalism. He has been severely castigated by authors who do not realise that this was a by-product of Rousseau's empiricism, and not for him an end in itself[27]. It was not that he doubted the value of his science, or of his philosophy generally, but rather the capacity of people to understand it.

Rousseau's science led him in two fundamentally opposite directions. His pre-occupation with life, or generation, led him towards the environmentalism of Montesquieu, and towards a more empirical science. This can be seen in his emphasis on the importance of the nature of climate and soil as determinants of the type of culture that will ensue (*e.g.* R.vi.114-115; *Du contrat social*). It is seen also in his expectation that different parts of the world will produce widely different peoples and customs: 'Que les hommes sont partout les mêmes . . . ce qui est à-peu-près aussi bien raisonné que si l'on disoit qu'on ne sauroit distinguer Pierre d'avec Jacques parcequ'ils ont tous deux un nez, une bouche, et des yeux' (R.i.191-375; *Discours sur l'inégalité*). Rousseau's science tended also in an opposite direction, away from an empirical approach, to an attitude which found its most rational expression in his relativism. Its most profound expression was in his belief in revolution and cataclysm in nature which, while it

[27] B. Russell, *History of western philosophy*, pp.711, 720, refers to Rousseau as 'the father of the romantic movement' and comments: 'The rejection of reason in favour of the heart was not, to my mind, an advance. In fact, no one thought of this device so long as reason appeared to be on the side of religious belief. In Rousseau's environment, reason, as represented by Voltaire, was opposed to religion, therefore away with reason!' Refer also I. Babbitt, *Rousseau and romanticism*, p.19.

brought him to the fringes of the irrational and the insane, is now accepted by geologists as having as much basis in fact as the 'fixiste' static universe of the mechanists. Here again Rousseau was opening the way for new thought on the subject.

The relativism, or rejection of absolutes, the argument for a science that is contingent, can be best seen in Rousseau's views on music. While on his first arrival in Paris, with his *Dissertation sur la musique moderne*, he proposed numbers instead of notes to simplify the reading of music (R.xv.35-159), notwithstanding, he greatly resented the tendency to mathematise it. That is why he entered into a prolonged controversy[28] with Rameau, who believed that music depends on numbers[29], which are timeless. Rameau was the author of the highly successful *Traité de l'harmonie*. He further demonstrated his expertise by composing thirty-five operas[30]. Rameau defined harmony as the basis of music, from which melody is derived, and argued that harmony depends on mathematical relationships[29]. Against this, Rousseau supported the primacy of melody[31]. Melody develops at a certain time, a result, he believed, of climate and condition; and he rejected mathematical explanations (R.xii.411; *Dictionnaire de musique*). This represented a conflict between the idea of change, or relativity, as being important, which Rousseau averred (R.xv.249-279; *Examen de deux principes avancés par m. Rameau*), against the idea of the timeless quality of art, or objectivity, as supported by Rameau[32].

These two positions both have their importance in musical appreciation: melody and harmony both count. Rousseau's claims

[28] J. Malignon, *Rameau*, pp.7-9, 99-100, gives details of what was known as the 'guerre des bouffons' between Rousseau, Rameau and their supporters.

[29] C. Girdlestone, *Jean-Philippe Rameau*, p.501.

[30] V. Weisstein, *TheEssence of opera*, p.65.

[31] R. Osmont, *Les Théories de Rousseau sur l'harmonie musicale et leurs relations avec son art d'écrivain*, pp.329-348.

[32] L. Gossman, 'Time and history in Rousseau', *Studies* (1964), xxx.311-349.

were important at the time if the views of Rameau, on the importance of harmony, were not to harden into orthodoxy. Rousseau, a self-taught musician, supported the claims of Italian music against those of French opera in the 'guerre des bouffons' which developed when a troupe of Italian players brought Pergolesi's *La Serva padrona* to Paris in 1752[33]. Against Rousseau it has been averred that eighteenth-century French opera was far less artificial than Italian, so that he was on the wrong side[34]. Certainly, his own music, when performed posthumously, failed[35]. Yet what he stood for is important: that music should not merely be technically well constituted, but that it should be melodic, at the same time. Notwithstanding the disapproval of musical connoisseurs, in our own day it is the melodic principle which has triumphed in popular music: to that extent it is Rousseau who has triumphed over Rameau.

The emphasis on revolution and cataclysm in nature represented a profound tendency in Rousseau's science. This reflects the influence of his religion more than of his empiricism, and was a dead end as far as science is concerned. It was the model of the unchanging universe, not the belief in constant and fundamental change, from which developed modern notions of evolution on which the sciences of biology and geology depend[36]. Rousseau's catastrophism, though it did not lead directly to modern theories of evolution, should not be discounted. Eighteenth-century science was caught in 'the mechanisation of the world picture', in the tendency to explain all phenomena in substantially similar terms. Catastrophism had an important rôle to play in criticising the extremely mechanistic contemporary science, and in freeing

[33] V. Weisstein, *The Essence of opera*, p.65.

[34] C. Girdlestone, p.501.

[35] H. Monin, 'Les Œuvres posthumes et la musique de Jean-Jacques Rousseau aux enfants-trouvés', *RHL* (1915), xxii.48-85, especially p.49.

[36] for a discussion of 'uniformitarianism and catastrophism', see R. Hooykaas, *The Principle of uniformity in geology, biology and theology*, pp.1-32, and the author's conclusion: 'The methodological principle underlying modern geology and evolutionary biology is the principle of uniformity' (p.1).

it, so as to permit of new thinking. On the negative side, Rousseau's catastrophism bordered on the irrational by dismissing the study of the physical sciences as pointless: 'Pour profiter dans l'étude des minéraux, il faut être chimiste et physicien; il faut faire des expériences pénibles et coûteuses, travailler dans les laboratoires, dépenser beaucoup d'argent et de temps . . . dans la fumée et souvent aux dépens de sa santé. De tout ce triste et fatigant travail résulte pour l'ordinaire beaucoup moins de savoir que d'orgueil' (R.xxi.271; *Rêveries*).

Admittedly, Rousseau lost his eyesight for more than six weeks as a result of an explosion while he was trying to make invisible ink (R.xvii.271; *Confessions*); and he was so affected that during this time he dictated his will[37]. But his rejection of the physical sciences ran deeper, to the religious substructure that lay below, to the postulate that 'tout est dans un flux continuel sur la terre' (R.xxi.229; *Rêveries*), which he employed to rebut the science of Voltaire. Accordingly, he rejected the study of geology as pointless, because: 'Le premier état de la terre différoit beaucoup de celui où elle est aujourd'hui' (R.i.521; *Essai sur l'origine des langages*). By the same token, Rousseau was sceptical of the claims of the mathematicians, the contemporary Pythagoreans, who argued against the reality of change, for mathematics is inapplicable where fundamental instability is in question. So: 'La géométrie seule donnera des théorèmes certains, mais sans usage dans la pratique' (R.xiv.349; *Dictionnaire de musique*).

The powerfully rationalist and religious bias of Rousseau's science is seen in his rejection of the geometry of Euclid in favour of that of the Oratorian P. Lamy[38]. Lamy was exiled by his order for an excessively Cartesian approach. He based his geometry on metaphysics. Rousseau wrote of geometry: 'Je ne goûtai pas celle d'Euclide, qui cherche plutôt la chaîne des démonstrations que la liaison des idées; je préférai la géométrie du P. Lamy qui dès-lors

[37] P. M. Masson, *La Religion de J.-J. Rousseau*, i.81.

[38] P. Costabel, *L'Oratoire de France et ses collèges*, pp.79-89.

devint un de mes auteurs favoris et dont je relis encore avec plaisir les ouvrages' (R.xvii.415; *Confessions*). Rousseau explained his preference for P. Lamy as follows: 'Ceux qui mêloient la dévotion aux sciences m'étoient les plus convenables: tels étoient particulièrement ceux de L'Oratoire et de Port Royal' (R.xvii.404; *Confessions*). Clearly, his science was the handmaid of his religion. On the positive side, Rousseau's catastrophism, which dismissed the physical sciences as irrelevant, allowed of no complacency by the exponents of physics, while his advocacy of the study of the life sciences provided a healthy antidote to the science of the previous century.

Furthermore, the belief that god proved his existence by incorporating a life force in matter can be extended, as it was by Rousseau[39], to the belief that man, in his natural state a product of god-animated matter, is fundamentally good. So peace with nature means peace with god, who animates nature, and the cycle of human happiness takes on a religious significance for Rousseau: rest, the country, the beauty of nature[40], with man enthroned as the most important of god's achievements[41]. A basis was established for the physiocrats' argument that all goodness comes from the earth, and for a preference for the study of such disciplines as veterinary science[42]. It was the fact of the debate on science in eighteenth-century France which set the stage for tremendous advances towards the end of the century by such men as Alembert, Lavoisier, Lagrange and Laplace, while the very success of the Newtonian synthesis in England, by putting an end to the debate on science, had a retarding effect on scientific discovery and inventiveness in that country.

Those who belittle Rousseau's science fail to understand the part it played in his search for god. At the same time, they fail to

[39] G. R. Havens, 'La Théorie de la bonté de l'homme chez J.-J. Rousseau', *RHL* (1925), xxxii.24-27.

[40] R. Mauzi, *L'Idée du bonheur au XVIII^e siècle*, p.374.

[41] J. Roger, *Les Sciences de la vie*, p.449.

[42] P. Huard, *L'Enseignement médico-chirurgical au XVIII^e siècle*, p.207.

recognise the importance of the debate on science as a liberating movement which made it possible for scientists to think more freely by subjecting orthodoxy to criticism, and by diminishing the hold of a mechanical science which otherwise ran the danger of not only stifling the thought of scientists, but of so hardening into an orthodoxy as to limit free and original thinking everywhere. In this sense the debate on science can be seen as parallel to, and not necessarily apart from, the debate on religion and politics which was generating a fermentation which would eventually prove more than the ancien régime could withstand. Taken in this way, Rousseau's science can be seen to be of cardinal importance to the history of thought generally.

CHAPTER 4

Science and the doctrine of man

What was the relationship between science and atheism in the French Enlightenment? Once again, the part played by the clandestine literature of the first part of the eighteenth century is of crucial significance: 'The impression is given that the deistic writers were more interested in destroying the foundations of revealed religion than in establishing the positive tenets of natural religion. This weakness in the positive arguments of the deists led to the rise of the atheistic writers who could and did use the deistic criticism of the events in the Bible for a different end'[1]. It is a shorter step from the deism of Voltaire to the atheism of Helvétius than it is from any orthodox Christian position to any deist one. Clearly, the discovery of contradictions within the *Bible*, if it is persisted in, may just as easily result in a complete discrediting of religion as in any deist system.

What has not hitherto been recognised is that there were two atheist positions, not one, each of which sought a scientific base, one relying on the physical sciences, the other on the life sciences. Atheism, which employed science as a rationale, did not derive from it. The use of two different scientific traditions resulted in modifications to the type of atheism being proposed. The debate between the proponents of these two different atheist positions is important because it resulted in a diffusion of atheism which could not have happened to the same extent otherwise. In order

[1] I. O. Wade, *The Clandestine organisation*, p.271.

to establish beyond reasonable doubt the existence of two different atheist positions, one seeking its support in the physical sciences, the other in the life sciences, it will be necessary to analyse the views of Helvétius and of Diderot as representative, respectively, of these different positions.

The importance of Helvétius is that he was able to extend the mechanical world view to justify egalitarianism and atheism. Hitherto, the use of the physical sciences had powerful inegalitarian tendencies, finding its typical expression in Voltaire's idea of an enlightened despot. By comparison, the use of the life sciences was more likely to result in a democratic point of view. The result of Helvétius's brilliant reasoning in *De l'homme* was to re-open the conflict between those who wanted to mechanise the world view, and their foes. What followed was an argument between schools of atheist opinion. Accordingly, an analysis of the science of the Enlightenment indicates that there was not a simple debate between the orthodox and the philosophes, or between conservatives and radicals amongst the philosophes. There was a series of controversies. The deists were arguing with each other, and so were the atheists, and the deists were combatting the atheists. While religion was their interest, the battleground was provided by their desperate efforts to establish their beliefs by reference to science. It is in this context that the thought of Helvétius assumes importance both as exemplifying a position, and because of its historical significance in eighteenth-century France.

i. Helvétius and science

The *philosophes* all accepted the belief that knowledge derives from the senses. They all rejected the Cartesian doctrine of innate ideas. They justified their position on empirical grounds, or by reference to the philosophy of Locke or Condillac. Sometimes they employed all of these arguments together. The rationalist

Cartesian position was rejected as representing the 'esprit de système', condemned particularly by Condillac (B.i.1-314; *Traité des systèmes*), which, they believed, stood in the way of truth. Their real objection was to Christian religious orthodoxy and, in particular, to the doctrine of original sin. Original sin is an innate idea on which the Christian beliefs in the fall and the redemption depend, as does Christian ethics. Further, the manner in which the Jesuits had harnessed Cartesian philosophy to their own ends showed how dangerous reliance on innate ideas could be for anyone who rejected Christianity. The *philosophes* relied on science to provide a rationale for their goal, which was to establish ethics on a new footing, separate altogether from religion.

The philosophy of Locke and of Condillac opened up new possibilities and set the *philosophes* on the way to the promised land. All they needed was to underpin the new sensationalist psychology with a scientific proof. A problem encountered by the *philosophes* in trying to establish their ethics on a scientific base was that there was a dualism within their science between support of the physical sciences, on the one hand, and of the life sciences on the other. The debate was between those who wanted to mechanise the mind, and those who upheld an organic position. Voltaire, and those who thought like him, saw the function of the mind as being to draw inferences from sense experience. Ideally, the mind performs like a perfect machine, drawing the appropriate conclusions from the given facts. Mathematics provides a model of the kind of reason intended. Not all minds are equally able. At one end of the scale was Newton, who discovered the laws of the universe, and who in the process exhibited remarkable powers of induction. At the other extreme was the *canaille*, who think little if at all.

Against this was the position of La Mettrie that the mind, like every other organ of the body, obeys laws of its own being. While it takes account of the environment, the mind responds on its own terms to it. This is an organic point of view. It was easy at

first to deride La Mettrie's position[2], because he was an atheist at a time when deism was in vogue with the *philosophes*. In this vein, Voltaire's *Poème sur la religion naturelle* was aimed at La Mettrie's *Anti-Sénèque*[3]. La Mettrie contributed to his own defeat by a confusion. He tried to establish his physiological interpretation by reference to mechanics. His argument that 'l'homme est une machine'[4] was propounded at a time when the physical sciences were well to the fore. In fact, La Mettrie's use of the mechanical sciences to establish a physiological doctrine was inappropriate[5]. Further, it blurred the lines of distinction by making it appear as if the only major difference between himself and Voltaire was that between a deist and an atheist.

A major point at issue between La Mettrie and Voltaire was that between an organic and a mechanical view of the mind. This resulted in a difference in emphasis on the rôle of the outside world. While for all the *philosophes* it was the facts of sense experience that counted, from La Mettrie's point of view the organic structure of the individual, and of his mind, determines the response, while for Voltaire the characteristic reaction is much more immediate and less individual. One placed more emphasis on individual differences than did the other. Here, in a new form, was the problem of 'the one' and 'the many', with La Mettrie, however confusedly, adopting a nominalist position. For Voltaire, the emphasis was on irritability. While recognising the importance of the stimulus from outside, La Mettrie put greater emphasis on sensitivity: on the response of the organism rather than on the spur to action. For one, what mattered was to respond to an objective, real world; for the other it was the subjective reality that counted.

[2] A. Vartanian, *La Mettrie's 'l'homme machine'*, pp.96-115.

[3] J. Pappas, *Voltaire and d'Alembert*, p.83.

[4] J. O. de La Mettrie, *L'Homme machine*, p.197.

[5] 'he does not present the organism as the specifically biochemical machine we know it to be'; A. Vartanian, *La Mettrie's 'l'homme machine'*, p.34.

While it was possible for Voltaire to dismiss La Mettrie as an atheist, without seriously analysing the other points at issue, their difference still stood. It remained as another source of division to torture the best minds of the French Enlightenment, and of those who came after. This debate was continued in the controversy on ethics between Helvétius and Diderot. This is important here as showing a division within atheist thought which arose out of the use of two different types of scientific argumentation, one borrowed from the physical sciences, the other from the life sciences.

Helvétius's views on science were confined to the physical sciences. Although the son of a doctor, he showed no interest in the life sciences. He relied on the achievement of Newton and of Locke. He aimed to parallel for ethics what Newton had achieved in mechanics, to extend the sensational psychology of Locke into ethics, and to establish ethics as a science based on laws and subject to mathematisation (DE.i.13). It is not generally recognised that a change occurred in Helvétius's thought between when he wrote *De l'esprit* in 1758, and *De l'homme*, which was written by 1769, but not published until 1772, two years after the death of its author[6]. The change was from deism to atheism, and from that of a supporter of enlightened despotism to a more egalitarian position. Each attitude was defended by reference to the physical sciences. Helvétius's thought is important as exemplifying how the proponents of the physical sciences could arrive at an egalitarian position similar to, though different from that of the proponents of the life sciences.

Helvétius was indebted to the physical sciences in two major respects: as a model for other branches of knowledge, and as revealing unchanging truth. His aim was to achieve for ethics the same kind of synthesis that had been reached already in the physical sciences: 'J'ai cru qu'on devait traiter la morale comme toutes les autres sciences, et faire une morale comme une physique

[6] I. Cumming, *Helvétius*, p.36.

expérimentale' (DE.i.13). If Helvétius was to arrive at an ethics to be universally true, he needed a principle to match the laws of science, a fact about human behaviour which is true for all men at all times. The belief that such a principle exists found its equivalent in the scientists' idea of an unchanging universe, in the universalism of the proponents of the physical sciences, which was strongly denied by, for example, Rousseau and Diderot.

Helvétius found his answer in the principle of pleasure and pain[7], which he believed to be empirically demonstrable, and which was reinforced by his sensationalist psychology, so that 'amour propre' becomes the dominant passion in men: 'La sensibilité physique a produit en nous l'amour du plaisir et la haine de la douleur' (DE.i.235). The human condition was seen by Helvétius to be represented by a pleasure/pain complex: 'Le plaisir et la douleur ont ensuite déposé et fait éclore dans tous les cœurs le germe de l'amour de soi, dont le développement a donné naissance aux passions, d'où sont sortis tous nos vices et toutes nos vertus' (DE.i.235). Helvétius likened the passions in men, from which pleasure and pain derive, as analogous to motion in the physical science: 'Les passions sont, dans le moral, ce que, dans la physique, est le mouvement' (DE.i.292). Just as matter and motion can explain the physical universe, they can also account for man's achievements in art and in other areas also. Once having established the passions, and, in particular, pleasure and pain, as the dynamic forces in men, it then becomes possible to derive a utilitarian ethics: 'La vertu n'est que le désir du bonheur des hommes; et qu'ainsi la probité, que je regarde comme la vertu mise en action, n'est, chez tous les peuples et dans tous les gouvernements divers, que l'habitude des actions utiles à sa nation' (DE.i.137).

In *De l'esprit*, while still working within the framework of Locke's sensationalist psychology, Helvétius had reached a different orientation. To Locke what mattered was the mind,

[7] E. C. Ladd, 'Helvétius and d'Holbach', *JHI* (1962), xxiii.221-238.

which employs sensations as its raw material from which to draw inferences. This was Voltaire's position also. It works against equality, because it depends on the individual how valuable are the conclusions he draws. For Helvétius, what mattered most were the impressions from outside. Depending on what they are, the mind will always draw the appropriate conclusions. This is still an inegalitarian resolution, however, as individuals differ greatly in their capacity to experience. Their answers vary greatly in value, from that of the genius down to that of the fool. While Helvétius made a distinction between 'sensibilité physique', or the experiences from outside, and 'mémoire', or reflection on them, what mattered most was the 'sensibilité physique' of which 'mémoire' was a mere extension (DE.i.21).

The 'grande inégalité des esprits' (DE.i.256) is not due to difference in human organisation. This can not be, as men are everywhere the same. It is due, Helvétius argued, to the strength of the passions which vary greatly in men: 'La force de notre attention est alors proportionnée à la force de notre passion' (DE.i.284). Although men are the same in all other respects, they differ in respect of the strength of their passions. How can we account for variation in human capacity, due to the strength of the passions, which can produce either genius or mediocrity? Helvétius' answer was chance and circumstance, which for him, when he wrote *De l'esprit*, amounted to much the same thing: 'L'homme de génie n'est donc que le produit des circonstances dans lesquelles cet homme s'est trouvé . . . l'homme de génie est en partie l'œuvre du hasard' (DE.ii.154, 167).

There was little difference between the position of the author of *De l'esprit* and that of Voltaire. The position taken was that of a deist whose proof for the existence of god was the Voltairean argument from a first cause and from design, with particular reference to Newton and to the physical sciences. What Helvétius intended was to extend this point of view, to develop a science of ethics analogous to Newton's physics, an ethics which would be founded on laws that could be tested empirically: 'La physique

et la morale sont comme deux colonnes isolées éloignées l'une de l'autre, mais qu'un jour un même chapiteau rejoindra'[8]. Another similarity with Voltaire was that the author of *De l'esprit* relied on an enlightened despot, a king, to introduce the new order[9].

There was only one major respect in which Helvétius's *De l'esprit* could be said to differ from Voltaire's point of view. That was in respect of the theory of knowledge which was advanced. Voltaire placed more emphasis on the rôle of reflection compared with Helvétius who relied on the passions as the way to knowledge. Even here the difference was less than would appear at first sight, as both were inegalitarian in their emphasis, one stressing variation in the human ability to reason, the other inequality in the capacity to experience. It was no coincidence that the views expressed in *De l'esprit* resembled those of Voltaire, who prided himself on having discovered the talents of Helvétius long before the latter published anything; but not before he sent indifferent verse to Voltaire for his opinion on it: 'Mon aimable ami, qui ferez honneur à tous les arts, et que j'aime tendrement. . . . Vous êtes né poëte' (Best.1368).

Helvétius's wealthy and influential father was physician to the queen. He had introduced his son to Voltaire in a letter of commendation[10]. Voltaire, who valued the prospect of a protégé at court, began a correspondence which lasted, off and on, to the death of Helvétius in 1770. Voltaire sent Helvétius a copy of the *Eléments de la philosophie de Newton* when it was first published in 1738 (Best.1905). He employed Helvétius to introduce people to court, and even wrote to him in English on the subject: 'Our friendship is so well known, my young Apollo, that everybody resorts to me, in order to obtain your benevolence' (Best.1905). In return, Helvétius employed Voltaire for opinions of his work, which, after correction by Helvétius, was sometimes shown to the king of Prussia (Best.2249). There was a rupture in the friendship

[8] C. Helvétius, *Pensées et réflexions; Œuvres complètes*, ed. by V. Lepetit, iii.293.

[9] A. McConnell, 'Helvétius' Russian pupils', *JHI* (1963), xxiv.373-386.

[10] I. Cumming, *Helvétius*, pp.5, 30.

of Voltaire and Helvétius from 1741 to 1758. They ceased to correspond after Helvétius demanded the immediate return of money he had lent to Voltaire's mistress, the marquise Du Châtelet, to help her pay gambling debts[11]. Helvétius's way of life, which resulted in his needing the money, also played its rôle in the severance of their correspondence.

Helvétius's passion for women was well known and seemed insatiable. He sought to slake it in the salon society of Paris. So ardent was his pursuit, that it cut across the intellectual lines of division of the salons, leading Helvétius from one to another. Madame la duchesse de Chaulnes, who conducted a salon, was his mistress for a time[12]. Helvétius's wife, to whom he was happily married[13], was an habituée of the salon of mme de Graffigny, her aunt, which was a meeting place for proponents of the life sciences, notably Turgot, who detested Helvétius, and Quesnay[14]. While Helvétius did not thereupon become an upholder of the life sciences, there seemed on the face of it a distinct possibility that he might. Worse than that, he was dealing with people who dissented from Voltaire.

The tremendous explosion occasioned by the publication of *De l'esprit* brought Voltaire and Helvétius together again. Shocked by the impact of his work, Helvétius wrote to Voltaire and quickly identified himself with his 'master': 'Dès que je pourrai, je vous enverrai donc mon ouvrage, comme un hommage que tout auteur doit à son maître' (Best.7130). Voltaire was forced to concede that the views of the author of *De l'esprit* were, in fact, remarkably similar to his own. While he disliked the furore, he would not deny the resemblance: 'Votre livre est dicté par la saine raison: partez vite, et quittez la France' (Best.7273).

Helvétius needed an assurance that Voltaire was in substantial agreement with *De l'esprit*. This was forthcoming: 'Vous me déplaire? et pourquoy et en quoy!' (Best.7342). In the same letter

[11] D. W. Smith, *Helvétius*, p.136.
[12] I. Cumming, *Helvétius*, p.36.
[13] F. Weil, 'Deux lettres inédites de Madame Helvétius', *RHL* (1959), lviii.373-375.
[14] D. W. Smith, *Helvétius*, p.161.

Voltaire invited Helvétius to be his guest. Thereafter he referred to Helvétius as 'mon illustre philosophe' (*e.g.* Best.12738). Helvétius continued to refer to Voltaire as 'mon illustre maître' (*e.g.* Best.12906). Helvétius did not publish *De l'homme* during his life-time. It would have found far less agreement from Voltaire. In it Helvétius gave evidence of having moved away from deism and inegalitarianism to atheism and democracy.

Helvétius's humanism was hammered out on the anvil of his suffering. The publication of *De l'esprit* because an issue in the struggle between orthodoxy and its foes. The Jesuits, who were striving to suppress Diderot's popular *Encyclopédie*, saw in *De l'esprit* the Achilles heel of the *philosophes*, as being easier to suppress than the *Encyclopédie*.

Helvétius's purpose in publishing *De l'esprit* was to provide an alternative interpretation of sensational psychology to that developed by Condillac, one which relied on a use of the physical sciences, compared with that of Condillac, which employed the arguments of the life scientists. In fact, Helvétius offered an alternative to the philosophy of Diderot and his colleagues, as set out in the *Encyclopédie*, to which Helvétius made no contributions[15].

Helvétius differed from Condillac in his theory of the mind. Condillac revived La Mettrie's nominalist sensationalism, but married it with orthodoxy in religion, and stripped it of its mechanical camouflage. He employed the first cause proof of the proponents of the life sciences, with god demonstrating his existence as the author of life: 'Voilà la création. Elle n'est, à notre égard, que l'action d'un premier principe, par laquelle les êtres, de non-existans, deviennent existans' (B.iii.428; *Traité des animaux*). Where Helvétius and Condillac diverged most was in the emphasis by the latter on difference in the method of operation of individual organisms, compared with Helvétius's stress on uniformity of response. Condillac employed a statue as his model

[15] D. W. Smith, *Helvétius*, p.189.

through which to demonstrate the wide range of possibilities where sense experience is in question (B.iii.37-256; *Traité des sensations*). The statue was given one sense after another, and the possible results discussed in detail. Condillac's was a descriptive and analytical science which eschewed generalisation. Condillac carried his reaction against the mechanical world view from the human to the animal realm: 'Il est impossible de concevoir que le mécanisme puisse seul régler les actions des animaux' (B.iii.349; *Traité des animaux*). He rejected the belief of the mechanists, for example of Descartes, that animals are machines, going even further than Buffon in the reinstatement of animals to claim that they can feel, think and judge (B.iii.359; *Traité des animaux*).

It transpired that there were in eighteenth-century France two schools of sensationalist psychology, one upheld by Condillac, the other by Helvétius; and that each one was able to claim to be the true inheritor of Locke. But whereas Condillac, like Diderot, La Mettrie and Rousseau, emphasised the nominalist psychology of the proponents of the life sciences, Helvétius upheld the mathematical, generalising proclivities of the proponents of the physical sciences.

What was seen by Helvétius as a dispute in the ranks of the *philosophes* was taken by their foes as part of a concerted programme against orthodoxy[16]. This becomes clear when Helvétius's frantic efforts are examined. In order to ensure no trouble, and to win opinion to his side, Helvétius had *De l'esprit* passed by the official censors before publication[17]. But the book aroused the ire of the Jesuits, who were themselves employing a mechanical world view, in their case that of Descartes, but which they now saw being sent by Helvétius in a direction away from the orthodox position.

In vain Helvétius, by his three retractions, strove to avoid a debate on religion[18]. What he saw was his book, which he had

[16] for a discussion of the 'affaire' see D. W. Smith, *Helvétius*, pp.11-91.

[17] *ibid.*, p.22.

[18] D. Mornet, *Les Origines intellectuelles*, p.131.

intended to win for him a claim to be the Newton of ethics, and which had been the produce of long travail, being branded as a mere anti-religious tract. The result of his struggle with orthodoxy was to lose him royal favour, and to endanger his mother's position as the friend of the queen. His struggle against authority sent Helvétius's thought along the road to humanism, egalitarianism, and atheism.

How could the rationale of the physical sciences be employed as a defence for a democratic credo? In *De l'esprit* Helvétius emphasised difference in the strength of the passions as distinguishing men of genius from mediocre men. In *De l'homme*, in strong contrast, he argued that, while all men start equal, their minds a blank, their potential is determined not by their own passion for learning, but by what they are taught: 'L'inégalité des esprits est l'effet d'une cause connue, et cette cause est la différence de l'éducation' (DH.ii.71). The activist element of the passions, which makes men unequal, has been replaced by an emphasis on the education of passive, receptive beings. Individual initiative, which is why people are unequal, is replaced by a social concept of training in equality, so that all men end up the same.

In order clearly to establish his change of position, Helvétius reversed his emphasis on the passions, not memory, as the way to knowledge, which is the message of *De l'esprit*, to the opposite of an emphasis on the memory, not the passions, as the appropriate road to truth: 'C'est à la mémoire (dont l'existence suppose la faculté de sentir) que l'homme doit et ses idées et son esprit. . . . Sans mémoire, point d'expérience, point de comparaison d'objets, point d'idées; et l'homme serait, dans sa vieillesse, ce qu'il était dans son enfance' (DH.ii.77). Whereas in *De l'esprit* what mattered was the 'esprit', the activist element in man, now it was to be the quality of his experience, a product of reflection, which has as its outcome the 'âme', the form of the person: 'L'esprit diffère donc essentiellement de l'âme en ce qu'on peut perdre l'un de son vivant, et qu'on ne perd l'autre qu'avec la vie' (DH.ii.77).

It might appear, on the face of it, as if Helvétius's position in *De l'homme* represented a return to a strictly Voltairean theory of knowledge, namely, to the emphasis on reasoning from sense experience. This is not so. The difference is in the rejection by Helvétius of the idea of variety in mental capacity. For Helvétius, in *De l'homme*, given the same experience, no two minds can draw different conclusions: 'Tous les hommes, il est vrai, n'éprouvent pas précisément les mêmes sensations; mais tous sentent les objets dans une proportion toujours la même. Tous ont donc une égale aptitude à l'esprit' (DH.ii.130). Clearly, this is a vastly more optimistic and egalitarian point of view than that of Voltaire. To Helvétius, the most difficult discoveries, as, for example, those of Newton, when clearly stated, can be understood by everyone (DH.ii.132).

Although the passions play a smaller rôle in *De l'homme* than in *De l'esprit*, Helvétius did not dismiss them altogether. He strove instead to equalise their importance. Towards this end he proposed a redistribution of land, so that each would have an equal capacity to enjoy, thus opening the way for Karl Marx, who carried on in this vein.

More typically, Helvétius argued for the greater importance of teaching as compared with learning in human affairs. This was seen in his controversy with Rousseau on education. Whereas in *Emile* Rousseau emphasised the importance of the individual in the learning process, Helvétius, an advocate of mass instruction, stressed the importance of the teacher, not the pupil. Here was the difference between 'irritability', the greater emphasis on the motor factor, by the proponents of the physical sciences; and 'sensitivity', the idea of inner direction, as advocated by the supporters of the life sciences. This difference explains why Rousseau was concerned to refute Helvétius' *De l'esprit* in his *Emile*[19], and

[19] A. Schinz, 'La "Profession de foi du vicaire savoyard" et le livre "de l'esprit" ', *RHL* (1910), xvii.225-261. See also P. M. Masson, 'Rousseau contre Helvétius', *RHL* (1911), xviii. 103-124.

why Helvétius aimed to ridicule Rousseau in his *De l'homme* (DH.ii.288-339).

In *De l'esprit* the rôle of chance and of circumstance was accepted as generally binding, and difficult to handle. So, while genius was to be developed through education, the process was not guaranteed to succeed in every instance. For example, it would never succeed, it was argued, if the government was not appropriate. In *De l'homme*, however, there was a far greater emphasis on education, and on the rôle of government, than in *De l'esprit*, and far more optimism about the outcome. Every man could now be a genius if the education system was geared to it. In *De l'esprit*, education was to be undertaken apart from the state. Legislation and education were considered as separate entities to be handled by different people. The function of education was to raise one, or at most a few, to the level of genius needed to legislate. No more was needed to produce an enlightened despot.

In *De l'homme*, however, legislation and education were integrated. The teaching of the pleasure/pain calculus was to be carried out by the same people who were measuring and adjusting the system. Here the function of education is to raise up every-man to the same level of genius. This becomes possible once learning is changed from an active to a passive principle. The result of this theory is to open the way to the possibility of democratising learning. The debate between the upholders of each strand of Helvétius's opinion continues, as does the conflict between the educational individualism of Rousseau and the two schemes advocated by Helvétius.

Whereas Diderot dismissed Helvétius's *De l'esprit* with contempt, he was amazed by what he read in *De l'homme*. He wrote to his mistress Sophie Volland in 1767 that: 'Helvétius . . . s'occupe à sa terre, à prouver que son valet de chiens auroit tout aussi bien fait le livre *De l'esprit* que lui' (*Correspondance*, ed. G. Roth, vii.159). Five years later his opinion of Helvétius had changed. Though he did not agree with *De l'homme*, he recognised its

importance when he wrote of it: 'Il sera pourtant compté parmi les grands livres du siècle' (A.-T.ii.274; *Réfutation suivie de l'ouvrage d'Helvétius intitulé l'homme*). It transpired, however, that the thoughts of Helvétius and of Diderot were incompatible. This is an important fact about European culture.

Diderot defended inner against other direction. He argued for the mind as an organism with a life of its own, against Helvétius's emphasis on the mind as an extension of the senses, which responds immediately to outside stimuli. Diderot claimed that the mind can store impressions, and compare them with new stimuli, and choose between them. Helvétius believed that the mind responds more simply and directly to impulses. Diderot argued that a person can prefer a long-term to an immediate gain: 'La folie consiste à préférer l'intérêt d'un moment au bonheur de sa vie' (A.-T.ii.393; *Réfutation*). Helvétius claimed that this only seems to be the case, that the anticipation of pleasure is in fact an immediate stimulus. The issue depends on whether the mind is seen as a mechanism or as an organism, a computer or a polyp.

The difference between men was another point at issue between Diderot and Helvétius. Diderot rejected Helvétius's belief that education matters most. Instead he adopted the nominalist position that what counts is the constitution of the individual, his texture or composition, the life force in him, so that men are not the same at all. It is variety in the structure of brains, and internal pressure working on the brain, which is responsible for different levels of intelligence. Accordingly, drugs can change the human constitution, and monster births can be normal ones. Helvétius took into account only those 'communément bien organisés' (DH.ii.201).

Diderot was closer to Rousseau's educational individualism than to Helvétius's emphasis on general teaching. He believed that individuals have different aptitudes. Like Rousseau, he put the individual needs ahead of those of organised society (A.-T. ii.374-375; *Réfutation*). Helvétius reversed the emphasis, arguing that in so doing man's best interests would be served.

Both Helvétius and Diderot strove to equate virtue and happiness. They differed in how they proposed to achieve the equation. Diderot rejected the mathematisation of politics as proposed by Helvétius, his felicific calculus, seeing in it the triumph of mechanism over the lives of men. His solution, like Rousseau's, was a belief in the general will, that man will, in the end, choose the good. His opposition to Helvétius's mechanical world view drove Diderot to accept, at the expense of his logic, individual self-determination[20]. In strong contrast, in both *De l'esprit* and in *De l'homme*, Helvétius relied on a mathematically-minded legislator to reconcile individual self-interest with the common good. He always believed that it was possible to bring about such a resolution: 'Les vices et les vertus d'un peuple sont toujours un effet nécessaire de sa législation' (DE.i.125). He proposed to achieve the reconciliation through a system of rewards and punishments.

There was a difference in orientation, however, between *De l'esprit* and *De l'homme*. Whereas at first the emphasis was on an enlightened despot, latterly it was on education as the means to the end. The trend was away from the man of genius to the genius of the people. There was less need for such a man, as the emphasis was moved from individual judgment to a more scientific approach. A sort of felicific calculus, not the individual judgment of a legislator, was most needed: 'On peut calculer la peur qu'un homme doit avoir du tonnerre dans un carrosse, dans un bateau'[21]. Diderot believed that Helvétius had over-simplified by reducing pleasure to the physical level. He argued for moral pleasures which are different from physical ones, thus rendering the mathematical approach inappropriate. He also argued for change in the human condition, so that no final solution is possible.

Although Helvétius defended democracy by reference to the mechanical world view, it was an uneasy resolution of the

[20] L. G. Crocker, *Two Diderot studies*, p.41.

[21] C. Helvétius, 'Notes, maximes et pensées', in *Œuvres*, ed. by A. Keim, p.274.

position. The intellectuality needed to develop the felicific calculus would lead more readily to an enlightened despotism than to anything else. In the debate between 'the one' and 'the many', between the universalism of the proponents of the physical sciences and the nominalism of the upholders of the life sciences, it seemed more likely that democracy would develop from the position of 'the many'. Helvétius's importance is not that he squared a circle, but that he showed that there are, at least in theory, more ways than one to democracy, and that each has its strengths and weaknesses, which can be debated by each side.

An analysis of the debate between Diderot and Helvétius results in two conclusions: that the controversy between these advocates of egalitarianism and atheism arose out of their use of contrasting scientific analyses; and that the points at issue between them, which were thoroughly analysed by Diderot, were not resolved. They still stand. In sharp contrast with Helvétius's use of the physical sciences to under-pin his atheist and democratic point of view, was Diderot's use, towards the same end, of the life sciences. In order to establish beyond reasonable doubt that this difference really exists, it will be necessary to examine Diderot's science.

ii. Diderot and science

What was the relationship between Diderot's science[1] and his views on other matters? There exists a conflict of opinion between those like Mornet[2] and Wilson[3] who see Diderot's atheism as a product of his science, compared with others, like Crocker[4], who

[1] the only exhaustive discussion of Diderot's science is by J. Mayer, *Diderot homme de science*. However, this is more a statement of Diderot's views on science than an analysis of their relationship with his thought on other matters.

[2] 'l'originalité de Diderot, ce n'est pas son matérialisme, c'est sa méthode. Il a fondé son matérialisme sur les sciences; il a été, en France, le premier matérialiste expérimental'; D. Mornet, *RHL* (1925), xxxii.142.

[3] A. M. Wilson, *Diderot. The testing years 1713-1759*, p.59.

[4] L. G. Crocker, *The Embattled philosopher*, p.170.

argue that Diderot's science was employed to uphold a philosophy derived by other means.

It is generally agreed that between 1746 and 1749 Diderot changed his position from being a deist to becoming an atheist. There is difference of opinion, however, as to the reasons for the shift that occurred in Diderot's thinking between when he published the *Pensées philosophiques* (A.-T.i.127-170) in 1746, and the *Lettre sur les aveugles* (A.-T.i.279-342) in 1749. What appears to have received little or no attention hitherto, rather surprisingly because it is a striking characteristic feature of this change, is that, whereas in the *Pensées philosophiques* Diderot employed the physical sciences to prove the existence of god, by 1749 he was using the life sciences to establish an atheist position. The deist arguments of the *Pensées philosophiques* were no advance on those of Voltaire. What was presented was the argument from the fact of a universe which is ordered, which obeys Newton's laws, to a belief in the existence of god: 'Ce n'est que dans les ouvrages de Newton, de Muschenbroek, d'Hartzoeker, et de Nieuwentit, qu'on a trouvé des preuves satisfaisantes de l'existence d'un être souverainement intelligent. Grâce aux travaux de ces grands hommes, le monde n'est plus un dieu, c'est une machine qui a ses roues, ses cordes, ses poulies, ses ressorts et ses poids' (A.-T.i.133). It was the clarity of exposition of the ideas, not their novelty, which resulted in a major impact[5].

In the *Lettre sur les aveugles*, and, in far more detail, in the *Interprétation de la nature* (A.-T.ii.9-63) on the other hand, Diderot was at great pains to reject the claims of the mathematical physical sciences in favour of the life sciences: 'Par quelle fatalité les sciences ont-elles fait si peu de progrès? ... Les sciences abstraites ont occupé trop longtemps et avec trop peu de fruit les meilleurs esprits' (A.-T.ii.18).

An early indication of this change is seen in his *Mémoires sur différents sujets de mathématiques* where he attempted to challenge

[5] A. M. Wilson, pp.54-58.

the accuracy of Newton's mathematics (A.-T.ix.176, 183-191). Although a sound mathematician, this line of approach proved to be something of a dead end for Diderot, as his mathematical knowledge, though considerable, was inadequate for the task[6]. At first Diderot contented himself with complaining of: 'L'obscurité qui règne dans les principes mathématiques de Newton' (A.-T.ii.215; *De l'Interprétation de la nature*). Later he had his revenge on Newton's complex mathematics in his *Bijoux indiscrets* (A.-T.iv.141-378) where, when one of the characters is attempting to explain Newton's mathematics, the reporter of the discourse comments to the reader that his account must end as the mathematics is incomprehensible. The story is taken up again two pages later (A.-T.iv.163). There are, then, two changes in Diderot's thought, both of which took place between 1746 and 1749, each of which requires to be explained. One of them is Diderot's move from deism to atheism, while the other is his use of the physical sciences to support his deism, compared with employing the life sciences to justify his atheism.

The explanation proposed here is that Diderot's change from the physical sciences, and from deism, represents the development of an increasingly democratic tendency manifest in both his politics and his religion, both products of his humanism. The use of the physical sciences to support a deist position had conservative political implications. Voltaire's study of the physical sciences resulted in an idolisation of Newton, who had demonstrated the importance of reason, the capacity to draw inferences from facts, and the use of the mathematical approach. It was no accident that Voltaire was, at the same time, a supporter of benevolent despotism in politics. Reason of the type exhibited by Newton is rare. As Voltaire required this in his legislator, it must needs make for an enlightened despot.

[6] for a discussion of Diderot's mathematics, see L. G. Krakeur and R. L. Krueger, 'The Mathematical writings of Diderot', *Isis* (1941), xxxviii.219-232.

It is not suggested that Voltaire's political conservatism, his support of benevolent despotism, though a logical extension of his use of the physical sciences, was due to his views on science. Benevolent despotism, though it could be derived by analogy from his views on science, was proposed by him as a rationalisation of a political attitude which in fact grew out of his own experience[7]. It resulted from his aristocratic pretensions, his rejection by the *chevalier* de Rohan, and his dismissal of the people as 'canaille'. His politics, like his deism, though they found their rationale in his science, were derived otherwise.

The use of the life sciences, compared with the physical sciences, to support a deist position, had democratic implications. Whereas intelligence, or reason, is very unevenly distributed, it can fairly readily be argued that one life is equivalent to another. The democratic implications of the use of the life sciences in philosophy were clearly spelt out by Rousseau in his *Du contrat social*. It is suggested that what caused the change in Diderot's scientific orientation, from the physical to the life sciences, was his growing dissatisfaction with the state of the nation. This was becoming apparent to him through his work in preparing the *Encyclopédie*. As his conflict with the authorities gained in momentum, and as his suffering grew in proportion, Diderot's thought became increasingly humane and democratic. It was bound to be only a matter of time before he changed his science to suit.

The developing democratic bias in Diderot's thought eventually occasioned a divergence between himself and Montesquieu. Although Diderot attended Montesquieu's funeral, they had grown further and further apart as Diderot became increasingly radical in his politics[8]. His period in gaol at Vincennes was a culminating point in his suffering. It made a great impression on

[7] P. Gay, *Voltaire's politics*, pp.87-116.

[8] A. M. Wilson, 'The Development and scope of Diderot's political thought', *Studies* (1963), xxvii.1871-1900.

him[9] and confirmed the change. Thereafter Diderot renounced his interest in the physical sciences. Diderot's humanism, resulting in egalitarianism, rather than anything inherent in science itself, was responsible for the reorientation of his science.

It is argued by Vartanian[10] that Diderot's change in scientific interest resulted from the influence on him of the fashions of the day, the trend away from the study of the physical to the life sciences. In favour of this interpretation he argues for the growing popularity of entomology, and stresses the importance of Réaumur's *Mémoires pour servir à l'histoire des insectes* for this development. However, it would be easy to over-state Réaumur's influence on Diderot, as they in fact quarrelled. The *Lettre sur les aveugles* was intended as a rebuke of Réaumur[11]. Vartanian also mentions the importance of the work of Bonnet, Bazin, Trembley, Jussieu 'and many others'. He then discusses the importance of Buffon's influence on the thought of Diderot. This is somewhat safer ground[12].

While the life sciences were gaining in popularity in eighteenth-century France, the physical sciences were holding their own. The predominance of the life sciences is seen in that Buffon's *Histoire naturelle* sold more widely than any book written and published in eighteenth-century France. It should not be forgotten, however, that the *abbé* Pluche's *Spectacle de la nature* sold almost as well, and was responsible for a developing interest in the physical sciences[13]. While it is true that the life sciences were gaining far more rapidly as the century advanced than were the physical sciences, this can only be advanced as a predisposing factor in Diderot's change, but is not adequate to account for so

[9] P. Bonnefon, 'Diderot prisonnier à Vincennes', *RHL* (1899), vi.200-224.

[10] A. Vartanian, 'From Deist to atheist. Diderot's philosophical orientation 1746-1749', *Diderot studies* (1949), i.46-63.

[11] A. M. Wilson, *Diderot. The testing years 1713-1759*, p.226.

[12] J. Roger, 'Diderot et Buffon en 1749', *Diderot studies* (1963), iv.221-236.

[13] D. Mornet, 'Les Enseignements des bibliothèques privées 1750-1780', *RHL* (1910), xvii.449-496.

dramatic and complete a reorientation as in fact took place between 1746 and 1749.

Diderot's switch from deism to atheism also needs to be explained. It is here advanced that the same humanism which was forcing on Diderot a move from the use of the physical to the life sciences was at work in his religious thought also. As a deist who rationalised his deism through the physical sciences, Diderot had argued that god demonstrated his existence through the order in the universe, both through the existence of motion in matter, in the Cartesian sense, and weight in matter, in the Newtonian sense. In order to move from the physical to the life sciences as a rationale for his philosophy, there was only one major change that Diderot had to make. In terms of the intellectual situation of his day, he would have to abandon his arguments from the physical sciences for the existence of god. Motion and weight would henceforth be seen, as they were by those who supported the life sciences, as properties of matter, not as proofs of the existence of god. At this point Diderot became an atheist.

To have supported his deism on the basis of the life sciences would have required Diderot to make a further change, to see god as the author of life. But like all the proponents of the physical sciences, he had previously taken it that life is a property of matter. In his *Pensées philosophiques* he had argued, like Voltaire, for god as the first cause of the universe, and its designer, with life as a derivative of matter. In order to move to the position of the proponents of the life sciences, Diderot had to take the stand that weight and motion are properties of matter. Having made this concession, which was the least required of him if he was to make a volte face in science, it was hardly likely that he would make a double reverse. It would be unreasonable of him to do anything other than to retain his belief in life, too, as a property of matter. This is what he in fact did: 'Alors la matière en général aura cinq ou six propriétés essentielles, la force morte ou vive, la longueur, la largeur, la profondeur, l'impénétrabilité, et la sensibilité. J'aurais ajouté l'attraction, si ce n'était peut-être une

conséquence du mouvement ou de la force' (A.-T.ix.269; *Eléments de physiologie*).

At the same time as Diderot's politics, his discontent with the state of the nation, was forcing him in a more radical direction, his criticism of the religious situation was increasing in proportion, and for the same reasons. He was a convinced atheist long before he wrote to Sophie Volland, his mistress, in 1765: 'Partout où l'on admet un Dieu, il y a un culte; partout où il y a un culte, l'ordre naturel des devoirs moraux est renversé, et la morale corrompue' (*Correspondance*, ed. by G. Roth, v.134).

While Diderot's change of position between 1746 and 1749 was chiefly for the reasons already given, sunk deep in his experience and thought, there were other forces moving him in the same direction. For example, a characteristic feature of advanced opinion amongst the *philosophes* was its atheism, and Diderot was to the fore in all experimental thinking. Furthermore, atheism was not only a logical development from deism, but a likely outcome once the anti-Christian propaganda of the deists had taken effect.

To argue which of his politics or his religion predominated in Diderot's changes between 1746 and 1749 is not necessary, as opposition to the status quo developed both political and religious discontent in him. The coincidence of Diderot's switch from support for the physical sciences to the life sciences, which came at the same time as his move from deism to atheism, reinforces the interpretation which is being advanced. The reasons which impelled him to make one change required him to make the other. Both his political and his religious discontents were products of his humanism.

Once having adopted an atheist position, Diderot was open to a challenge from determinism. The deist can retain the Christian ethical system, whereas the atheist is required to develop an alternative. Diderot's humanism[14], which had driven him to

[14] J. Thomas, *L'Humanisme de Diderot*, pp.75-80.

change his scientific orientation, which had at the same time forced him to move from deism to atheism, thereby raised the problem of determinism, which posed an even greater challenge to his humanism than had been present at the outset. It is some index of the intellectual capacity of Diderot that he continued to move forward, trying to resolve the new problems, and that he did not return to the point of departure of his thinking.

Diderot preferred to take his chance in the ethical no man's land which his atheism required, than to accept the political and religious conservatism proposed by the enlightened despotism and deism of Voltaire. The typical expression of his opinion is to be found as much in his support of the life sciences as in his atheism.

Crocker sees an unresolved dualism in the thought of Diderot, between the logic of his thought on science, which led him to atheism, and, on the other hand, his sentimentalism, or humanism, which drew him in an opposite direction, to bourgeois morality[15]. What is being advanced here is to see this not as a debate within Diderot's thought, but as a development out of his humanism, where his political and religious humanism required both a a democratic solution, and the use of the life sciences. This raised a new problem, the need for an ethical system, which was the price he had to pay for the change in his thought.

Vartanian's explanation of Diderot's atheism relies on the influence on him of the science of La Mettrie[16], and the effect on him of the discovery by Trembley of his polyp, which was taken to have established spontaneous generation. There were additional predisposing factors, but are not enough in themselves to explain the extent of Diderot's switch. He employed them to justify a change he made for other reasons altogether.

[15] 'his inexorable rationalism led him to atheism, materialism, determinism, amoralism, anarchy. His bourgeois sentimentalism led him to virtue, moralizing, humanitarianism, and the defense of property rights'; L. G. Crocker, *The Embattled philosopher*, p.347.

[16] A. Vartanian, *Trembley's polyp, La Mettrie, and eighteenth-century French materialism*, pp.497-516.

Wilson accounts for Diderot's atheism in terms of his science, in particular by reference to a principle of economy[17]. It was for Diderot scientifically more elegant and economical to assume that weight, or life, or motion, are properties of matter, than to introduce an explanation that relied on god. This is to over-simplify the science of Diderot, by seeing it as an integrated whole. The result is to not recognise the transition in Diderot's thought from the use of the physical to the life sciences, and to thereby fail to appreciate the importance of his humanist dilemma. It was this which was making Diderot increasingly more radical, not only in politics and religion, but in science also.

A weakness of the arguments of Wilson and Vartanian, compared with Crocker's interpretation, depends on the recognition by the latter of the ethical problems raised for Diderot by his atheism, and the degree of effort he spent on resolving them. What should be recognised is that he employed science as a means to that end. Having dispensed with god, Diderot found it necessary to develop a naturalistic system of knowledge, and a naturalistic ethics. These are our inheritance from the Enlightenment[18]. As an atheist, Diderot rejected the idea of a god-instilled natural law. He substituted the idea of knowledge being derived through the senses, particularly through touch. He owed this emphasis on the senses to the influential sensationalist psychology of the half-blind intellectual *abbé* Condillac, whose psychology was of crucial importance to the proponents of the life sciences.

Condillac's psychology freed the proponents of the life sciences from reliance on the mechanist emphasis on reason as the way to knowledge, and made it possible for them to substitute the senses instead. It was in this vein that Diderot claimed, in his *Lettre sur*

[17] 'he always seemed impelled to follow a principle that one might call the principle of greatest possible economy.... He left God out simply because the existence of God was unnecessary, according to this view, to explain the universe'; A. M. Wilson, *Diderot. The testing years 1713-1759*, p.59.

[18] L. G. Crocker, *An Age of crisis*, pp.378-388.

les aveugles, that a man blind from birth, who suddenly regains the ability to see, will not be able to recognise an object unless he can first touch it, that the eyes are an extension of the arms, and depend ultimately on touch.

Having dispensed with Christian ethics, Diderot had to develop a new ethical system. He substituted a naturalistic ethics based on the belief in happiness: 'Plaisir et douleur sont et seront toujours les seuls principes des actions des hommes. J'en conviens' (A.-T.ii.310; *Réfutation*). The principle that men want to be happy had for Diderot the validity of a scientifically established fact, as it was, in his opinion, empirically verifiable. What mattered to Diderot was the greatest happiness of the greatest number. Technology was for him a means to the end of happiness. That is one reason why he pioneered the giant *Encyclopédie* of the arts and crafts of his day. What he was popularising was atheism and technology. The mixture proved singularly acceptable to contemporary Frenchmen, and it is still popular.

At the root of Diderot's apparent solution of the ethical problem raised by his atheism was an unresolved dualism between his desire for logic, and his humanist beliefs. In the end he accepted the compromise solution of a double truth. This left the way open for the criticism of a Sade: the happiness of some men is to obey laws; the happiness of others is to break them. If there is no god, no ethical imperative, what logical argument is there to address to the man who likes to torture or to kill? If 'thou shalt not kill' is no longer the fifth commandment, why should it be observed at all? Diderot's answer was the double truth: happiness for the people, and an unresolved nihilist problem for the enlightened to think about[19].

Diderot made one major effort to overcome the dualism which he had inherited from Descartes[20]. It was in his physiology that he endeavoured to resolve the problem. His aim was to integrate

[19] L. G. Crocker, *The Emblattled philosopher*, p.170. See also the same author's *Nature and culture*, p.386.

[20] A. Vartanian, *Diderot and Descartes*, pp.135-200.

reason and feeling[21]. He was faced with a challenge from those who wished to give primacy to reason, represented by the mechanists, for example, by Voltaire and Helvétius. From the side of the proponents of the life sciences, a threat was posed by the determinists, who explained the human condition in terms of the blind forces of nature. This position was represented for Diderot by La Mettrie.

Diderot's solution to the dualism of reason and nature was to argue for a mind and a body which work in harmony, the mind integrating impulses from both inside and outside the human system. This resembled very closely Leibniz's analogy of two clocks running exactly parallel but independently of one another, an analogy which impressed Diderot: 'Je vois plus de tête dans l'Harmonie préétablie de Leibniz . . . que dans les plus grandes découvertes, soit en géométrie, soit en mécanique, soit en astronomie' (A.-T.ii.348; *Réfutation*). The différence was that for Diderot there was not just a parallelism, but an interaction between body and mind. As far as Diderot was concerned, his physiology represented an integration, for all practical purposes, of the dualism of body and mind, which he achieved by deriving both physiologically. He set out the results in his *Eléments de physiologie*, his major work in science. He was aware that the question of which is ultimately prior, the mind or the body, still stood, but dismissed it as irrelevant in practice, though interesting in theory, and insoluble.

Crocker rightly argues that his inability to resolve the dualism of mind and matter left Diderot's theory open to nihilist implications[22]. One reason why Diderot moved more and more away from theory to practice, from philosophy to life, from science to technology, was because he believed that the practice mattered

[21] 'Diderot rejette tout dualisme'; H. Dieckmann, *Cinq leçons sur Diderot*, p.53.

[22] 'Diderot never convinced himself intellectually that nihilism was wrong, that moral values had any status other than as the power-enforced demands of the social group'; L. G. Crocker, *Nature and culture*, p.386.

more than the theory, that his humanism mattered more than his logic. This point of view found its fulfilment for Diderot in his technology, which appealed to him because it stood for his rejection of the physical sciences, and worked for improving the human condition generally. In time, Diderot came to concern himself more and more with the practicalities of the *Encyclopédie*, and to turn away from the attempt made in the *Eléments de physiologie* to resolve the dualism of mind and matter, a problem which lay dormant in his philosophy.

Diderot's use of the life sciences to support his philosophy had important implications both for his science and for his atheism. As life was what interested Diderot, it was in physiology, medicine, chemistry and biology that were to be found his interests in science. Ultimately for Diderot, science was reducible to physiology, or else was nonsense. Even chemical changes were seen by him as physiological in character. The other life sciences were ranked lower than physiology in Diderot's scheme of things.

Diderot's emphasis on physiology was a sharp reaction against the new kind of mathematical physics[23]. His attack has been likened to Aristotle's criticism of Plato for being abstract and mathematical, so driving the life, colour and activity out of nature[24]. It was in his *Eléments de physiologie* that Diderot hoped to make his major contribution to science. It represents an integration of the organic and the inorganic which is still crucial to modern physiology[25]. In this way it was far superior to any other physiological theories being advanced at the time[26]. Yet it was more the work of a philosopher than of a scientist[27]. This was because Diderot saw it as his function to synthesise the work of others rather than to undertake experimental work on his own account (A.-T.ii.349; *Réfutation*).

[23] S. Toulmin and J. Goodfield, *The Architecture of matter*, p.237.

[24] *ibid.*, p.235.

[25] L. G. Crocker, *The Embattled philosopher*, p.99.

[26] J. A. Perkins, 'Diderot and La Mettrie', *Studies* (1959), x.71.

[27] 'il est vrai que Diderot n'expérimentait pas'; J. Mayer, *Diderot homme de science*, p.8.

Diderot's preference for philosophy over science becomes very obvious in his *Lettre sur les aveugles*, which is a discussion of how a man blind from birth would behave if he suddenly regained his sight. Diderot was at pains to criticise Réaumur for not waiting until he himself was present when a blind man saw, thus making it necessary to theorise rather than to investigate the facts. Yet later on, of Daviel, he wrote: 'J'ai assisté plusieurs fois à ses opérations' (A.-T.i.333). Daviel was performing the type of operation which Diderot describes in his *Lettre sur les aveugles*, from 1728 on, and he carried out 226 in 1752 alone, 182 of them being successful[28]. Yet Diderot gives no indication of having shown any interest in testing his expectations of what such men might see compared with the facts of the matter.

Notwithstanding, the importance of the *Eléments de physiologie* is that it kept alive the debate on science, which provided a stimulus not merely to scientific achievement, but for argumentation amongst the intelligentsia of the day, and for consideration by a growing public in eighteenth-century France. It follows that the debate was not a simple one between the orthodox and the unbelievers, but a controversy at all levels, between the orthodox themselves, amongst the scientists, and the deists with each other, and it also split the atheists. Diderot based his atheist position on current views of science, and took great care to stay abreast of the state of the question in the life sciences[29]. This added to his contemporary significance. The *Eléments de physiologie* is important, too, because the *Encyclopédie* represents no more than an extension and generalisation of the principles set out there.

Diderot's science was intended to destroy the world view of the physical scientists. It was in preformation theory that he felt was the Achilles heel of the mechanists, and which concerned him most in the *Eléments de physiologie*. He derived his own alternative theory of fermentation and transformism physiologically, and in opposition to the mechanist preformation theory[30]. Alembert is

[28] editors' footnote in A.-T.i.333.
[29] J. Mayer, p.243.
[30] J. Mayer, p.180.

quoted as having asked him: 'Vous ne croyez donc pas aux germes préexistants? Diderot: Non' (A.-T.ii.110; *Le Rêve de d'Alembert*). Diderot rejected preformation on empirical grounds. He claimed that it would be foolish to think that the animal species has always been what it is.

For Diderot, life comes through fermentation. He derived this belief from his postulate, which he took to be a matter of fact, and which was shared by most of the life scientists, of a universe composed of atoms in motion. Atoms in motion produce heat, which results in fermentation: 'Dans le commencement . . . la matière en fermentation faisait éclore l'univers' (A.-T.i.310; *Lettre sur les aveugles*). From fermentation it is possible to derive life, or, as Diderot called it, 'sensibility'. He was able to distinguish three different types of fermentation: 'Trois degrés dans la fermentation: la vineuse, l'acide, la putride. Ce sont comme trois climats différents sous lesquels les générations d'animaux changent' (A.-T.ix.264; *Eléments de physiologie*). Hence the importance of climate, or environment, in his scheme of things (*e.g.* A.-T.iii.497). First there was vegetation from which, by fermentation, life, both human and animal, derived: 'La végétation, la vie ou la sensibilité, et l'animalisation sont trois opérations successives' (A.-T.ix.265; *Eléments*). It followed for Diderot that spontaneous generation is feasible: 'Par la chaleur et la fermentation, la matière végétale s'animalise dans un vase' (A.-T. ix.256; *Eléments*).

A. Vartanian[31] properly stresses Diderot's belief[32] that spontaneous generation was demonstrated in Trembley's polyp. Diderot also accepted that Adanson had discovered an aquatic plant which reproduced spontaneously (A.-T.ix.368; *Eléments*). The importance of spontaneous generation for Diderot was that, as preformation and spontaneous generation are incompatible, and as it seemed that spontaneous generation had been established, ferment theory should now become the new orthodoxy, and have

[31] A. Vartanian, *Trembley's polyp*, pp.497-516.

[32] 'le polype n'est qu'un intestin vivant' (A.-T.ix.386; *Eléments*).

with it a powerful empirical basis in spontaneous generation. It was in his *Rêve de d'Alembert* (A.-T.ii.105-191) that Diderot developed and extended ferment theory, in the form of his doctrine of transformism[33]. This was intended to deal a final blow to preformation. Suppose a statue of a man. This can be broken up into fine particles, which can then be used to fertilise the earth. A plant may be produced which will include grains from the statue. A man may gain nutrition from the plant. The man will later die, and his bones go to dust, to be later used to make a statue, and so on. It follows that man differs from nature merely by virtue of a temporary organic superiority. Transformism thus stands for a complete reversal of the 'chain of being' concept: the effect of transformism is to derive man from below rather than from above[34].

Although Diderot succeeded in freeing himself of the reigning orthodoxy of preformation, he did not arrive at the alternative of epigenesis. This was due to his support of an extreme form of change, namely, transformism, which stood for catastrophism in nature. This in turn destroyed the possibility of a rational basis for a science of biology. He adopted a nominalist position, which emphasised variety and change: 'L'univers ne me semble quelquefois qu'un assemblage d'êtres monstrueux' (A.-T.ix.418: *Eléments*). Whatever rules were set down for now, would change, as they had in the past.

So great was Diderot's dislike of the mechanical world view, that he rejected attraction, or the sex impulse, as basic to generation. This was thought to be too close to mechanist views of the matter, as seen, for example, in Voltaire's science, where attraction and mechanism were powerfully integrated. Diderot referred to 'le mystère de la génération' (A.-T.ii.25; *De l'interprétation de la nature*) simply because he was far from convinced that

[33] for a discussion of Diderot's transformism, see L. G. Crocker, *Diderot and eighteenth-century French transformism*, pp.114-143.

[34] L. G. Crocker, *An Age of crisis*, p.80.

reproduction is necessarily sexual. He noted the existence of hermaphrodites in nature (*e.g.* A.-T.ix.421) and of remarkable similarities between male and female sexuality: 'On a découvert qu'il y a dans un sexe le même fluide séminal que dans l'autre sexe' (A.-T.ii.17; *De l'Interprétation*). For Diderot, the only real difference between the sexes is physiological. This opens the way to the possibility of all sorts of change and variation. It is far removed from Darwin's idea of the selective action of external conditions, but rather champions more radical transformist ideas[35], such as were frequently held by ferment theorists. Cataclysm in biology found its equivalent, in Diderot's thought, in catastrophism in geology[36]. Just as everything in his biology could be changed by a different ferment, so, in geology, all could be altered by a new climate.

By challenging preformation, and by promoting the importance of the idea of change, Diderot weakened existing orthodoxy, thus making its overthrow possible. He also developed a serious consideration of the other element, change, which, together with hereditary characteristics, was to provide the basis on which to make a transition to the modern theory of epigenesis. By the same token, Diderot's doctrine of transformism, though not the progenitor of the modern theory of evolution, which derives more from the 'fixiste' universe of Voltaire than from transformism[37], was important nonetheless. Diderot's challenge helped to

[35] this differs from H. Dieckmann's assertion that 'Nobody familiar with the history of science will deny that Diderot anticipated indeed some of the fundamental ideas in the field of biology', in 'The First edition of Diderot's "Pensées sur l'interpretation de la nature"', *Isis* (1955), xlviii.251-267. The author makes no effort to substantiate his assertion. Compare L. G. Crocker on Diderot's biology: 'His ideas, purely speculative, were of no particular value to scientists', in *The Embattled philosopher*, p.140. This in turn goes too far the other way.

[36] *e.g.* A.-T.vi.343, *Lettre sur Boulanger*; A.-T.i.311, *Lettre sur les aveugles*.

[37] 'it is a commonplace in the history of biology that the rise of the evolution theory was a necessary consequence of the introduction of the principle of uniformity into geology'; R. Hooykaas, *The Principle of uniformity*, p.3.

undermine existing orthodoxy, and thus open the way to change. Furthermore, by emphasising revolution in his science, Diderot set the stage for a synthesis of constancy and environment from which the modern theory of evolution derives.

It was the ability of ferment theory to explain so much, and without reference to mathematics, that was its appeal. Even electricity and magnetism were susceptible to explanation in terms of heat and ferment theory. These were explained as being due to the heat generated by the action of atoms in motion, which results in the movement of the earth, which in turn generates electricity and magnetism: 'Il y a grande apparence que le magnétisme et l'électricité dépendent des mêmes causes. Pourquoi ne seraient-ce pas des effets du mouvement de rotation du globe et de l'énergie des matières dont il est composé combinée avec l'action de la lune?' (A.-T.ii.27; *De l'Interprétation*).

Diderot took the smell of sulphur, which is present in electrical experimentation, as proof of heat (A.-T.ii.28). The sparks that occur during electrical experimentation provided a further link. He was a supporter of Franklin's work, and it showed a connection between electricity and lightning; and he employed Le Monnier, a follower of Franklin, to write articles for the *Encyclopédie* on electricity and magnetism[38].

In his attack on the mechanical world view, Diderot did not confine himself to rejecting preformation in favour of fermentation. He went further, to attack the chief bastion of the mechanists, the scientific synthesis of sir Isaac Newton. It followed from Diderot's postulate of matter in motion that laws of physics are out of the question. What he needed was to demonstrate this principle in such a way as to reveal for all to see the fallacies of the mechanical world view. In this vein, Diderot laid his axe at the root of Newton's integration of the inverse square law of attraction, with Kepler's planetary laws[39].

[38] I. B. Cohen, 'A Note concerning Diderot and Franklin', *Isis* (1955), xlvi.268-272.

[39] O. Bluh and J. D. Elder, *Principles and applications of physics*, p.181.

In his *Réflexions sur une difficulté proposée contre la manière dont les newtoniens expliquent la cohésion des corps et les autres phénomènes qui s'y rapportent* Diderot simply disagreed that the inverse square law of attraction applied on earth: 'La force avec laquelle les corps pesants, et nommément les planètes, se portent vers le centre de leur tendance, est toujours réciproquement proportionnelle au carré de la distance; et celle avec laquelle les particules s'approchent et s'unissent dans les cohésions etc., est manifestement plus grande. Il semble donc que ces deux forces ne peuvent pas être produites par une seule et même cause' (A.-T. ix.183-191). Diderot's criticism of Newton's synthesis was extremely shrewd and well judged, as it was not until the nineteenth century that it proved possible to demonstrate that the inverse square law of attraction, on which Newton's 'universal law of gravitation' depends, in fact applies to matter[40]. As well as penetrating deeply, Diderot's claims here follow logically from his belief in a changing universe. It was a legitimate attack.

While Diderot's aim was to destroy the mechanical world view, he had no wish to fall victim to the deism of Rousseau, either. That is why, in *La Botanique mise à la portée de tout le monde*, he went on to disparage the study of botany, beloved by Rousseau, complaining that: 'Il n'y a pas de science plus pénible, et plus fugitive' (A.-T.vi.375). He went on to criticise botany more fundamentally still, on the grounds that it shared, along with the physical sciences, the dreaded 'esprit de système', the tendency to argue without reference to the facts, so as to create a logically coherent argument without empirical foundations: 'La méthode est excellente dans les choses de raisonnement, mauvaise à mon avis, dans celles de nomenclature et c'est précisément le

[40] 'On account of the inaccuracy of their apparatus, a direct measurement of the attraction between two masses in a laboratory experiment seemed impossible for Newton and his successors for a long time. Cavendish (1798) was the first to determine the attraction between two masses'; *ibid.*, p.183.

cas de l'histoire naturelle en général et spécialement de la botanique' (A.-T.vi.376).

Nevertheless, forced to choose between the mechanical world view and the science of Rousseau, Diderot preferred the latter. That is why he was on the side of Rousseau, and opposed to Rameau, in the 'guerre des bouffons'. The mechanists, in particular Voltaire and Alembert, were on the side of Rameau. Diderot had his revenge in *Le Neveu de Rameau*, where he ridiculed the great man through his nephew (A.-T.v.387-488). In his *Leçons de clavecin et principes d'harmonie* he made a frontal assault by working to de-mathematise the structure of harmony, so as to bring it into accord with nature (A.-T.xii.171-534).

Diderot extended his attack on the mechanical world view from music into art. The purpose of art, as of music, should be to imitate nature[41], because nature is always right: 'La nature ne fait rien d'incorrect. Toute forme, belle ou laide, a sa cause; et, de tous les êtres qui existent, il n'y en a pas un qui ne soit comme il doit être' (A.-T.x.461; *Essai sur la peinture*). The reason why nature is right is because life in all its forms derives from that source: 'Les peintres, les poëtes, les sculpteurs, les musiciens et la foule des arts adjacents naissent de la terre' (A.-T.xi.86; *Salon de 1767*). His own criticism of art depended simply on whether or not the work in question was true to nature, in which case he praised it, or was artificial, when it was condemned.

Diderot's dedication to technology was an outcome of his concern with the life sciences and of his rejection of the physical sciences. The *Encyclopédie* enshrined the principles of the mediaeval arts and crafts, of mixing, and blending, and stood for the rejection of mathematisation, or quantification, which was the sign in which the physical sciences conquered. The science of the *Encyclopédie*, whether drawn up by Diderot himself or by other contributors, agreed in all essential points with his own

[41] in the *Salon de 1765* Diderot referred to 'les arts, qui ont pour objet d'imiter la nature' (A.-T.x.233).

views on science. Most of the articles which dealt with the theory of science were in fact contributed by Diderot himself, which ensured a correspondence. For example, in his article[42] on 'Chaos', Diderot rejected the concept of a static universe: 'Le docteur Burnet assure, avec raison, que si l'on excepte Aristote et les pythagoreans, personne n'a jamais soutenu que notre monde ait eu de toute éternité la même forme que nous lui voyons' (*Encyclopédie*, iii.158). Instead, Diderot substituted the ferment theorists' belief in a world shaped by revolution.

In his article[42] on 'Chaldeans', Diderot went on to generate ridicule for the study of the stars, as advocated by Newton[43], and the proponents of the physical sciences, by which they hoped to determine the origin of the universe: 'Mais de ce système d'observations, purement arbitraire, il n'en résultera jamais que le monde ait toujours existé, ou qu'il doive toujours durer . . . mais parce que je n'avois que des calculs qui ne traînent après eux aucune révolution dans les choses humaines, je ne puis les regarder que comme les rêveries d'un calculateur' (*Encyclopédie*, iii.22-23).

What Diderot, and the other contributors to the *Encyclopédie*, were promulgating, was the study of life. In his article[44] 'Cadavre', Diderot complained that: 'La conservation de la vie est un objet . . . trop négligé par la société' (*Encyclopédie*, ii.511). Towards this end he advocated the study of anatomy and of physiology. Because the *Encyclopédie* enshrined the life sciences as being amongst the disciplines most useful to men, medicine figured largely[45]. As was general with proponents of the life sciences, the importance of the use of drugs was emphasised. Botany was seen as providing the raw material for cures by drugs (*e.g.* 'Acmella'; *Encyclopédie*, i.108). Some of the cures were far removed from modern science. It was claimed for the root 'Agaty'

[42] A. M. Wilson, *Diderot. The testing years 1713-1759*, p.208.

[43] F. E. Manuel, *Isaac Newton historian*, pp.21-36, 50-77.

[44] A. M. Wilson, *Diderot. The testing years 1713-1759*, p.199.

[45] J. Mayer, *Diderot homme de science*, p.362, agrees: 'Dans l'*Encyclopédie*, la médecine tient encore la place d'honneur'.

that: 'Sa racine broyée dans de l'urine de vache dissipe les tumeurs' (*Encyclopédie*, i.169). The articles on farmers, and on grain, were from the ferment theorist Quesnay[46]. Le Monnier wrote the articles on magnetism and electricity[47]. He, like Quesnay, was the king's physician, and an exponent of Franklin's electricity[48], which included in it powerful elements of ferment theory.

It was not until four volumes of the *Encyclopédie* had been published that Voltaire was asked to contribute. Even then, the offer came from him. He contributed only three articles to volume five, on 'Elégance', 'Eloquence', and on 'Esprit' and fifteen articles to volume six, which were on literary matters, not science. Alembert, who was Voltaire's man in Paris, and nominally equal with Diderot as co-editor of the *Encyclopédie*, resigned from his position on 6 January 1758[49]. His resignation came as a result of criticism he received from Rousseau for his article 'Genève' (*Encyclopédie*, vii.578-582). Alembert's resignation resulted in a rift with Diderot. Neither Voltaire nor Alembert contributed to the *Encyclopédie* after that. Even as joint editor with Diderot, Alembert's influence was less, as his own interest in mechanics, and the time he spent at it, resulted in less effort for the *Encyclopédie*, where Diderot always dominated. Nonetheless, Alembert's resignation meant that the bias in favour of the life sciences, present from the outset, was intensified as a result.

Voltaire's aim was that the *Encyclopédie* should be ended or that he should have control of it himself. On 6 January 1758 he wrote to Diderot to advise him to suspend publication of the *Encyclopédie*, or else to produce it from outside France (*Correspondance*, ed. by G. Roth, ii.29). Diderot declined. Voltaire was astonished that Diderot was able to go on producing the *Encyclopédie*, without Alembert, and virtually on his own: 'Neuf volumes

[46] A. M. Wilson, *Diderot. The testing years 1713-1759*, pp.253, 276.

[47] E. Bauer, *Electricity and magnetism in the eighteenth century*, p.477.

[48] I. B. Cohen, *Benjamin Franklin's experiments*, p.121.

[49] A. M. Wilson, *Diderot. The testing years 1713-1759*, pp.214, 237, 253, 287.

de l'Encyclopédie. Cela est incroyable' (*Correspondance*, iii.277). Voltaire's concern is understandable. It was the *Encyclopédie*, next to Buffon's *Histoire naturelle*, which, more than any other contemporary publications, made for the triumph of the life sciences, and for the rejection of the mathematical quantitative approach, at least in the eyes of the reading public.

All the ramifications of the victory of the life sciences cannot be examined in this study. However, their triumph doubtless played a part in the expulsion of Diderot's erst-while foes, the Jesuits, in 1762, because they taught the physical sciences in their schools. Mme de Pompadour, who was instrumental in their expulsion, was sympathetic towards Diderot, and wrote to him in 1753 in appreciation of what he, and his colleagues, were doing: 'Une société d'hommes laborieux, et qui n'ont d'autre prétention que celle d'être utiles à leurs semblables, consacrent plusieurs années à la rédaction d'un ouvrage qui doit être le dépôt des connaissances humaines' (*Correspondance*, ed. by G. Roth, i.160). The influence of the propaganda of the proponents of the life sciences can be seen, also, in the opposition of the French revolutionary governments to most orthodox scientific institutions, which historians of science are currently investigating[50].

[50] C. C. Gillispie, *The Encyclopédie and the Jacobin philosophy of science*, pp.255-289.

CHAPTER 5

Science and government

The clandestine literature of the first half of the eighteenth century resolved itself into two traditions of protest: the politics of reform by kings, and of reform by nobles, the 'thèse royale' and the 'thèse nobiliaire'[1]. The group of deists who converged around the comte de Boulainvilliers argued for a golden age in the past, before the triumph of the state over the estates[2]. Others, such as Meslier[3], looked to the future, when the idea of the state would be fulfilled by an enlightened legislator. Both schools of opinion were idealistic, believing that kings, or nobles, could govern more efficiently than they did. One group idealised the past. The other reversed the procedure and glorified the future.

These two traditions of protest, the 'thèse royale' and the 'thèse nobiliaire', found their foremost exponents, amongst the philosophes, in Voltaire and in Montesquieu respectively. Voltaire gloried in what had been achieved so far. His hero was Newton. He found a parallel and a near equivalent in Louis XIV, whose reign had witnessed hitherto unequalled achievements in statecraft, and in culture generally. In sharp contrast was Montesquieu, who arraigned the present before the bar of a far less corrupted past. His golden age was not the reign of Louis XIV, whom he criticised, but the days before Charlemagne. It has been seen that Voltaire's politics, his deism, and his science, formed an integrated whole. His emphasis on 'reason' as the important thing

[1] for a discussion of these terms, see P. Gay, *Voltaire's politics*, pp.87-116.

[2] V. Buranelli, 'The Historical and political thought of Boulainvilliers', *JHI* (1957), xviii.475-494.

[3] G. Lanson, 'Sur l'histoire de l'esprit philosophique en France avant 1750', *RHL* (1912), xix.9.

made for his adulation of Newton; and for his deism, which he favoured as being the lowest common denominator of religion; and for his enlightened despotism, which encouraged his search for a legislator cast in the same mould as Newton. His integrated philosophy was an outcome of his own experience.

How did Montesquieu arrive at the 'thèse nobiliaire'? What was the relationship between his science and his views on other matters? these questions assume importance when it is realised that Rousseau's 'thèse démocratique' derived far more from Montesquieu's 'thèse nobiliaire' than from the 'thèse royale' of Voltaire. Whereas it seemed to the clandestine writers of the first half of the eighteenth century that the chance of reform was between the 'thèse royale' and the 'thèse nobiliaire', it transpired in the course of the French revolution that the real choice was between the 'thèse royale' and the 'thèse démocratique', between reform by kings or by peoples. In this regard, Montesquieu's thought proved to be seminal and influential. The political principles he set down were carried to their logical conclusion by Diderot and Rousseau, who, though they differed from him, were deeply in his debt. It was this development that made it possible to defeat the 'thèse royale'. While the debate between those who advocated reform by kings and reform by nobles seemed to be won, in France at any rate, by Voltaire rather than by Montesquieu, the extension of Montesquieu's views to the 'thèse démocratique' ultimately swung the balance back the other way.

Montesquieu is important for another reason. He was an exponent of ferment theory. It was his alliance of the 'thèse nobiliaire' to the life sciences that ensured a logical transition to the 'thèse démocratique'. If life is what matters most, then it is more logical to be a democrat in politics than to be an exponent of aristocratic government. Montesquieu stopped short of democracy for personal reasons. Because of his own condition, the baron de La Brède was no democrat. However, there was little in his thought which might prevent it from being taken to democracy.

Montesquieu's importance is that he was the first to show how the life sciences could be employed to combat the emphasis on reason, with its inegalitarian bias, as championed by Voltaire. Once Montesquieu pointed the way, it became possible for others, notably for Rousseau, and Diderot, to take the matter further.

In Montesquieu's work can be seen the transition from the deism and aristocratic politics of Boulainvilliers, which were justified on historical grounds, to much the same views being justified not only by reference to history, but by the use of the life sciences also. In the process, the brilliant and fertile genius of Montesquieu developed political ideas which allow him to be ranked along with Rousseau and ahead of Voltaire and Diderot, as foremost amongst the political theorists produced in the Enlightenment.

By employing both the historical method of Boulainvilliers and his school, together with the life sciences, as a rationale, Montesquieu undoubtedly strengthened the case for the 'thèse nobiliaire'. In the process he swung it in a more radical direction which set it on the way towards the 'thèse démocratique' of Rousseau.

There was an incongruity between Montesquieu's use of history and science as supports for his ideas. The use of a historical rationale has both conservative and reactionary implications. These were carefully worked out by Edmund Burke[4]. The use of the life sciences, on the other hand, has radical political implications. These were developed by Rousseau who, in the interests of political radicalism, placed far less reliance on history. So, for example, he nowhere defends his state of nature as having been a historical fact, but rather claimed it was a logically necessary condition.

As Montesquieu's thought was so influential in the Enlightenment, and dominates so much of it, and because of his stature as a

[4] C. P. Courtney, *Montesquieu and Burke*, p.1.

political theorist, it is relevant to investigate more closely than has been done so far, the relationship between his science[5] and his views on other matters.

Those who support the view that Montesquieu was a rationalist, relying on a deductive approach, normally represent him as being Cartesian in his science, a way of thinking to which he was introduced by Malebranche[6]. The alternative opinion about Montesquieu is to see him as a pioneer of sociology who relied on an empirical science[7]. Implicit in these divergent interpretations is an obvious difference about whether Montesquieu's science was primarily rationalist or empirical in its emphasis, and a lack of clarity about what his science really was.

One of the difficulties in answering questions about Montesquieu is that, as he grew older, he changed his position. The influence on him of the rationalism of Descartes was profound when he published the *Lettres persanes* in 1721[8], and up to when he went on his European travels in 1728. Thereafter Montesquieu incorporated more and more empiricism into his thinking, so that

[5] although all his commentators refer to Montesquieu's science, there exists no statement of what his own views on science really were, or of the relationship between his science and his thoughts on other matters.

[6] this view was first most clearly formulated by G. Lanson, *Revue de métaphysique et de morale*, p.540, and J. Dedieu, *Montesquieu*, p.110. F. Neumann in his 'Introduction' to *The Spirit of the laws*, p.xxxiv, claims: 'It is thus Descartes and Malebranche far more than Locke who determined Montesquieu's scientific method'.

[7] this interpretation of the work of Montesquieu was pioneered by Emile Durkheim in 1892. His work was translated and reprinted in 1960 under the title *Montesquieu and Rousseau, forerunners of sociology*, where he makes such claims as: 'Induction made its first appearance in social science with Montesquieu' (p.53), and: 'It is Montesquieu who first laid down the fundamental principles of social science' (p.60). This interpretation has been further developed by W. Stark, *Montesquieu*: 'We know from his own pen that science and empiricism were to him more or less the same thing' (p.6). See also S. Cotta, *Montesquieu e la scienza della società*, who argues: 'Gli scritti scientifici rappresentano il momento dell'analisi empirica' (p.174).

[8] C. J. Beyer, 'Montesquieu et le relativisme esthétique', *Studies* (1963), xxiv.175-177.

by the time he published *L'Esprit des lois* in 1748, his work reflected a degree of empiricism which is still the subject of controversy.

It will be argued here that Montesquieu's belief in the importance of 'climate' in *L'Esprit des lois* was an extension of his science. So far, Montesquieu's insistence on the importance of 'climate' has been explained in terms of his empiricism; but its place in his thinking before *L'Esprit des lois* had not been shown. Shackleton's definitive *Montesquieu* sums up the state of the question with: 'The belief that climate is a major factor governing human societies is not found in the early writings of Montesquieu' (p.302). It will be argued that Montesquieu's science was rationalist, but that it found an empirical equivalent in 'climate' at a time when his thinking generally was becoming more empirical.

Montesquieu's views on science were developed before he went on his travels in 1728, so that his science reflects more than anything else the deep and abiding influence on him of the rationalism of Malebranche and of Descartes. His interest in science came early in his life, from when he joined the Académie de Bordeaux. This Academy was formed in 1712, a result of the growing preoccupation of French thinkers with scientific studies. It was an imitation of the Académie des sciences in Paris. Montesquieu's position as 'président à mortier' of the *parlement* at Bordeaux, and as baron de La Brède, gave him a prominence in Bordeaux society which resulted in an invitation in 1716 to join the Academy, which was then only four years old. The invitation was of great significance in his intellectual development because, whereas up to 1716 Montesquieu had shown little or no interest in science, from 1716 to 1728, when he went on his European travels, he was profoundly influenced by it.

In sharp contrast with Descartes, who was a mechanist[9], Montesquieu was a ferment theorist in his science. He took his stand

[9] L. Brunschvicq, *L'Expérience humaine et la causalité physique*, pp.196-238.

in biology. He aimed to overthrow the mechanical synthesis of Newton, and of Descartes, by extending principles from biology to explain the other sciences. A characteristic feature of the resulting cleavage was that, whereas Descartes emphasised the use of mathematics in physics[10], Montesquieu opposed it[11].

Montesquieu was a deist[12] who employed science to prove the existence of god. He made use of the argument from a first cause, a line of proof similar to that to be developed by Voltaire. Both Montesquieu and Voltaire presented the argument for a first cause as if it was a scientific demonstration: 'On parloit de l'existence de Dieu. Je dis: "En voilà une preuve en deux paroles: il y a un effet, donc il y a une cause"' (N.ii.641; *Pensées*). A difference between Voltaire and Montesquieu was that Montesquieu relied far more on biology than on physics for his proof of the existence of god. Another difference was that he did not employ Voltaire's second line of argumentation, his reference to design, which worked from the wondrous order in nature, as revealed in Newton's synthesis, to the view that this could not result any other way than from god. Montesquieu opposed this 'proof' because he believed that, as matter is in a constant state of flux, there can be no designer of it.

While for both Montesquieu and Descartes, what counted was the fact of matter, there was a major difference in their orientation to it, which opens up a contrast between the use of the physical sciences compared with the life sciences. Whereas what counted for Descartes was extension and motion, Montesquieu concerned himself with a god-incorporated life force in matter. It was because Montesquieu's concern was with life that he devoted most of his attention to biology and botany. What is it that causes plants to develop and to multiply? Montesquieu believed that it is ferment, an invisible property of matter, which is responsible.

[10] E. J. Dijksterhuis, *The Mechanisation of the world picture*, p.404.

[11] P. Barrière, *Un grand provincial*, p.341.

[12] R. Shackleton, pp.349-355: 'it is in deism that is to be found the real religious belief of Montesquieu' (p.352).

Montesquieu did not invent the idea of ferment which, though not employed by Descartes, had had a long history by his time. However, Montesquieu was original in his use of the idea, particularly in stripping ferment of much of its traditional spiritualist and vitalist significance.

Montesquieu acknowledged his debt to German chemists (N.ii.73; *Pensées*), from whom he derived the idea that ferment is the key to the origin of life. This need not surprise. For example, Johann van Helmont (1577-1644), whose works were available in French, stressed the importance of ferment, a notion dating back to the origins of chemistry[13].

Montesquieu either was unaware that Camerarius had established plant sexuality in 1692, or else he paid no heed to the fact. It is most likely that he knew nothing of it, as he made no mention of Camerarius or his work. It is not surprising, as this was a time of controversy in science, when all sorts of claims were being made, relating particularly to spontaneous generation, so that it took time for a new orthodoxy to win supporters. It was for Rousseau, as we have seen, to attempt to reconcile plant sexuality with the type of ferment theory supported by Montesquieu.

According to Montesquieu's use of the idea of ferment, plant life is generated through the movement outwards from the earth of an invisible liqueur which, when it comes into contact with the air, ferments, and plant life results: 'On voit par tout ceci que l'accroissement des plantes et la circulation de leurs sucs sont deux effets liés et nécessaires d'une même cause, je veux dire la fermentation' (N.iii.111; *Essai d'observations*). Montesquieu believed that the life force is initially put into matter by god, but that afterwards it works according to the logic of circumstance and chance: 'Nous osons donc le dire, et nous le disons sans rougir, quoique nous parlions devant des philosophes: nous croyons qu'il n'y a rien de si fortuit que la production des plantes; que leur végétation ne diffère que de très-peu de celle des pierres et des

[13] M. Daumas, *The Chemistry of principles*, pp.322-325.

métaux; en un mot que la plante la mieux organisée n'est qu'un effet simple et facile du mouvement général de la matière' (N.iii.108; *Essai d'observations*).

Montesquieu upheld ferment, and rejected mechanist alternatives, in order to save the world from atheism. Conversely, he disputed that his attribution of a life force to matter, his belief in ferment, opened the way to atheism, holding rather that it worked to establish the existence of god: 'Quelques philosophes ont prétendu décréditer le ferment en disant qu'il n'étoit pas un nouveau lien; et moi, je dis que, quand il n'y auroit de Divinité, le ferment seroit un nouveau lien' (N.iii.615; *Chapitres et fragments de 'l'esprit des lois'*). In order to put the matter beyond dispute, he went on to extend the principles of his biology and botany into other branches of science.

For Montesquieu, there was a close relationship between botany and geology, in that the same force which makes for plant life makes also for the formation of rocks and stones. The difference between whether it is rocks or plants which result is fortuitous. With plants, the life force withdraws quickly on contact with the air, so that it is not crushed, and plants result. With stones, no such withdrawal takes place, so that the life force from the earth is solidified by the air with which it comes into contact, and stones result instead of plants. He called the process of withdrawal which results in plants 'intussusception', and solidification, which produces stones, 'juxtaposition': 'On distingue la végétation des plantes d'avec celle des pierres et des métaux: on dit que les plantes croissent par intussusception, et les pierres par juxtaposition' (N.iii.108; *Essai d'observations*).

Montesquieu also addressed himself to the problem of the origin of the life of animals and of men. Animals presented him with no problem, as he believed that they, like plants, are a product of fermentation. Animals are unlike men, he believed, the difference being that men can think. Animals he likened to stringed instruments: 'Les animaux sont des espèces d'instrumens à corde: leurs nerfs y font la fonction des cordes dans les

instrumens de musique' (N.ii.495; *Pensées*). Montesquieu was able to carry out very cruel experiments on animals, such as the drowning of ducks, and the scorching of sheep, without qualms, as he believed animals to be like plants: 'Les brebis ne crient pas quand on les écorche parce que les cris ne sont pas, dans leur machine, l'expression de la douleur' (N.ii.162; *Pensées*).

Montesquieu believed that with animals, as with plants, the life force comes from ferment, from the earth: 'Il semble que les semences des plantes ayent de l'analogie aux œufs des animaux: l'esprit séminal en est dans la terre' (N.ii.197; *Pensées*). Accordingly, he argued that animals are similar in constitution to plants: 'L'organisation, soit des plantes, soit des animaux, ne peut guère être autre chose que le mouvement des liqueurs dans les tuyaux' (N.ii.23; *Pensées*).

Montesquieu experienced greater difficulty in explaining human generation. He was unwilling to extend the same line of reasoning from animals to humans, as this would have broken through the distinction between men and animals by reducing men to the same level of environmental subjection to which he had reduced animals. He was prepared to argue as a materialist so long as it did not affect his metaphysics, but he preferred to sacrifice his science rather than to dethrone man. He admitted that he lacked knowledge of the answer on human reproduction (N.iii.114; *Essai d'observations*). He promised to write on the subject at some later date (N.iii.117), a promise which he did not keep. Montesquieu was sure that there must be some difference between human and animal reproduction which would account for the fact that men can think. He hoped to find a solution to the problem of human reproduction and constitution. He did not doubt that he was near the answer, though he knew that he had not arrived at it: 'On ne sçait pas expliquer de quelle manière cette liqueur séparée, filtrée, gardée dans ces organes, produit ces effets' (N.iii.406; *Essai sur les causes*).

It is unlikely that Montesquieu at any time doubted the applicability of the principles of his science to human biology. At the

same time that Montesquieu was investigating, Maupertuis was resolving the problems of human reproduction in other ways altogether, and carrying out fundamental pioneering work in genetics. If Montesquieu had doubted the applicability of his ferment principles to biology, Maupertuis could have provided him with some salutary alternatives. The two were well known to each other, for Montesquieu had visited Maupertuis in Berlin, and the latter arranged for Montesquieu to become a member of the Berlin Academy (N.iii.1071; *Correspondance*).

Montesquieu, however, rejected the work of Maupertuis, based, as it was, on the analysis of animals, and arguing, by analogy, to human reproduction. Furthermore, Montesquieu could not accept heredity as being in any sense important in reproduction. He was an environmentalist. Montesquieu recognised that the principles of human reproduction were not yet established. He took steps to set the matter straight by instituting in the Académie de Bordeaux a prize on the nature of the renal glands. The response was so poor that he did not allow the prize to be presented, contenting himself with criticising the contributions of those who had made submissions (N.iii.78-86; *Discours sur l'usage des glandes rénales*).

The difficulties currently being experienced in solving the problems of biology was one of the reasons which resulted in a great enthusiasm in Montesquieu for medicine. He believed that through the study of medicine would be resolved the nature of human reproduction, so that: 'Les recherches anatomiques sont une hymne merveilleuse à la louange du Créateur' (N.iii.78). Through the study of anatomy would be revealed the rôle of god in human reproduction: 'Le philosophe s'étonne et trouve l'immense grandeur de Dieu dans l'action d'un muscle comme dans le débrouillement du chaos' (N.iii.78).

It is difficult at this point in time to realise the importance of the impact made by the Cartesian and Newtonian syntheses. Variously stated and differently interpreted though they were, the point at issue remained the same: whether or not to mechanise

the world picture. The obvious religious significance of this issue ensured that it would be keenly contested. Newton's and Descartes's testimony were employed on both sides. Sometimes these syntheses were seen as high-points in mechanist interpretation, in the tradition of the physical sciences. At other times, Newton's achievement was interpreted as Baconian, in the manner of the life sciences. More typically, the names of Newton and of Descartes were employed as slogans in a grim war between the mechanists, the proponents of the physical sciences, and their foes, who employed the life sciences as a rationale. This makes it necessary to go behind the slogans to see what is really meant where the names of Newton and of Descartes are in question.

In the conflict that was to develop between the supporters of the science of Newton, and that of Descartes, Montesquieu, though he differed from both, placed himself squarely behind the Cartesians. Montesquieu's support of Descartes's physics went beyond his adherence to the facts of science to the religious substructure, which concerned him more. Montesquieu rejected Newton for fear of atheism, and represented Descartes as a champion of religion: 'Le système de Newton mène donc droit à l'athéisme. Ils supposent l'espace pour se passer de Dieu et une attraction pour se passer d'un moteur' (N.ii.823; *Spicilège*). Conversely, Montesquieu supported the science of Descartes because it worked against atheism: 'Descartes . . . ce grand homme fut sans cesse accusé d'athéisme et l'on n'emploie pas aujourd'hui, contre les athées, de plus forts argumens que les siens' (N.i.493; *Défense de l'Esprit des lois*).

Montesquieu feared that the Newtonians, by relying on cosmological argumentation, would bring about a repetition of what had happened when the Aristotelian cosmology had been displaced. A change in the scientists' view of the universe had then been able to shake the foundations of religion. If god was employed, as he was by Voltaire, as part of a static theory of physics, then the existence of god would depend on a wrong theory of science, which is contingent, so that god might

eventually seem to be explained away. Montesquieu sustained his argument against Newton on two grounds: that Newton's position depends on mathematics, or geometry, of which he was critical, and that Newton abused geometry anyway, so that he was a mere creator of another unestablished system.

It is sometimes argued against Montesquieu that his critical attitude towards mathematics and geometry was a result of his failure to master them[14]. Certainly, he found this a difficult field; but there were few in his own time who could confidently claim to understand the mathematics of Newton's *Principia*. In reality, Montesquieu's criticism of mathematics was far more sophisticated and fundamental. He believed that mathematics and geometry depend on presuppositions that may be true or false, but which cannot be demonstrated: 'Les propositions mathématiques sont reçues comme vrayes parce que personne n'a intérêt qu'elles soyent fausses' (N.ii.218; *Pensées*). Further, Montesquieu was suspicious of geometry as a family concern: 'Ce qui me choque de la géométrie et m'en dérobe la sublimité, c'est que c'est une affaire de famille, et que les géomètres viennent de père en fils. Combien avons-nous vu de Bernoullis?' (N.ii.228; *Pensées*). Mathematics not only did not help science: it hindered its development: 'Les méthodes des géomètres sont des espèces de chaînes qui les lient et les empêchent de s'écarter' (N.ii.303; *Pensées*). He was then in a position to cast doubt on Newton's use of geometry: 'Il pourroit bien être que Newton auroit souvent été lu sur l'opinion de l'infaillibilité de la géométrie' (N.ii.848; *Spicilège*).

Montesquieu argued that no new truths are discovered through the use of mathematics; or else, and here he was thinking of Newton, true facts which could be established in other ways seem to be demonstrated, but from false premises: 'Le mathématicien ne va que du vrai au vrai, du faux au vrai, par les argumens ab absurdo. Ils ne connoissent pas ce milieu qui est le probable, le plus ou le moins probable' (N.ii.53; *Pensées*). That he was

[14] M. Barckhausen, *Montesquieu*, pp.303, 322.

thinking of Newton becomes clear from his *Spicilège*: 'Il pourroit bien être que Newton auroit beaucoup abusé de la géométrie, et, comme il arrive souvent, que ses calculs seroient bons et ses suppositions fausses' (N.ii.848). To Montesquieu, Newton's science, though seemingly correct, was founded on false suppositions, which made it just another system: 'Nous n'entendons plus les anciens systèmes. . . . Nous ne connoissons pas plus le système d'Héraclite que nous connaîtrons celui de Newton en lisant "La Pesanteur et le Vide de Newton" ' (N.ii.83; *Pensées*). Montesquieu rejected the ideas of absolute space and absolute time, on which the Newtonian synthesis depends, as false, as representing the despised 'esprit de système'.

Ever since the Aristotelian earth-centred cosmology had been shown to be inappropriate, systems were shunned: 'Les observations sont l'histoire de la physique, et les systèmes en sont la fable' (N.ii.51; *Pensées*). The English stood condemned in the matter of making systems: 'D'ailleurs, l'imagination fait bien inventer les systèmes et, en cela, les Anglois ont fourni leur contingent plus que toute autre nation' (N.ii.72; *Pensées*). The attack on Newton was maintained by Montesquieu consistently throughout all his work. At no time did he regard Newtonian physics as anything but a chimera which would result in those who relied on it ending up as atheists.

Montesquieu carried his objection to Voltaire and the other Newtonians in France to the extent of trying to undermine not only the mathematics they championed, but their science also. The view to which Montesquieu the scientist was most opposed was that life originated from pre-existing germs created by god. Preformation theory, as upheld by Voltaire, and by other supporters of the atomic theory of Epicurus and Gassendi[15], was strongly opposed by Montesquieu: 'C'est une grande erreur de dire que la plante est contenue dans la graine, et une plus grande encore, que la première a contenu toutes celles qui devoient

[15] J. S. Spink, *French free-thought from Gassendi to Voltaire*, pp.75-102.

naître' (N.ii.298; *Pensées*). It seemed to Montesquieu that he could provide a scientific disproof of preformation: 'Si l'on met dans la terre un bâton vert, il poussera des racines et des branches, et deviendra un arbre parfait . . . ainsi, s'il est vrai qu'un arbre ne soit que le développement d'une graine qui le produit, il faudra dire qu'une graine étoit comme cachée dans ce bâton de saule: ce que, je crois, personne ne peut penser' (N.iii.107; *Essai d'observations*). However, a far more rigorously empirical approach is required to resolve the problem.

Montesquieu believed that the life force comes from ferment, which changes all the time, not from a pre-existing grain which does not change at all. In support of his belief, Montesquieu argued the variability of the species: 'Je suis persuadé que les espèces changent et varient extraordinairement, qu'il s'en perd et s'en forme de nouvelles' (N.ii.34; *Pensées*). Doubtless that is why one commentator has lauded Montesquieu as a pioneer of evolution[16]. Montesquieu did not agree with deists like Voltaire who claimed that god created the world in its existing form. Against Voltaire's: 'Toutes les espèces sont demeurées invariablement les mêmes; il serait bien étrange que la graine de millet conservât éternellement sa nature, et que le globe entier variât la sienne' (M.xxiii.228), Montesquieu replied: 'La terre change si fort tous les jours qu'elle donnera sans cesse de l'emploi aux physiciens et observateurs' (N.ii.34; *Pensées*).

Cockle-shells found on the tops of mountains seemed to Montesquieu to indicate that major changes had taken place in the natural history of the world. It was to his purpose to emphasise the importance of these changes, in order to disprove the idea of an unchanging universe handed down by god in its present form. At the same time, like most proponents of the life sciences, Montesquieu rejected an explanation in terms of the deluge, or water, in favour of a more drastic explanation, or volcanic explosions

[16] B. Kassem, *Décadence et absolutisme dans l'œuvre de Montesquieu*, p.18.

and catastrophism: 'Le déluge n'étoit pas universel. L'eau, dit l'Ecriture, alloit au-dessus des plus hautes montagnes; cependant l'expérience nous fait voir que l'eau ne montant que 27 pieds' (N.ii.792; *Spicilège*). The only problem left for Montesquieu was to select a change which would succeed where the Deluge had failed, a change which would completely alter the face of the earth and thus render untenable all views which argued for an unchanging universe, and for the constancy of laws of science: 'Si, par exemple, le centre de gravité de la terre venoit à changer . . . il y auroit un transport de la mer ailleurs . . . ce qui est rocher et banc de sable se trouveroit montagne' (N.ii.425; *Spicilège*).

His travels abroad have rightly been accepted as of fundamental importance in understanding Montesquieu's intellectual development, and in understanding his views on science[17]. Whereas up to when he went abroad, Montesquieu was interested in science, he did not continue his work in science after his return[18], and disconnected himself from the 'Académie de Bordeaux'. E. Cassirer has explained this change by reference to the fact that Montesquieu's eyesight was barely functioning[19]. A more likely explanation is that a developing interest in empiricism came to hold his attention more than his highly rationalistic science[20].

While Montesquieu retained throughout his life all his former scientific beliefs[21], he developed alongside them more empirical attitudes. These led him away from the laboratory towards the application of science to society, and found their major outlet in the development from his science of an emphasis on the rôle of climate in human affairs. This change becomes clear for all to see

[17] S. Cotta, *Montesquieu e la scienza della società*, p.222.

[18] *ibid.*, p.84.

[19] E. Cassirer, *The Philosophy of the enlightenment*, p.47. See also A. Sorel, *Montesquieu*, p.9: 'Mais sa vue, qui fut toujours faible, lui rendait les expériences difficiles'.

[20] R. Shackleton, *Montesquieu*, pp. 259-261.

[21] that the voyages overseas represent an important development of tendencies already present in Montesquieu's thought, and not a break with the past, is borne out by R. Shackleton, 'La Genèse de L'Esprit des lois', *RHL* (1952), lii.425-438.

in his most important work, *De L'Esprit des lois*. Another reason why Montesquieu went from science to the study of society is because he believed that almost all the important discoveries had been made in science: 'Nous sommes presque réduits à pleurer, comme Alexandre, de ce que nos pères ont tout et n'ont rien laissé à notre gloire' (N.iii.54; *Discours prononcé à la rentrée de l'académie de Bordeaux*).

A nascent empiricism, combined with his optimism about the happy state of knowledge of the sciences, directed Montesquieu's interest away from scientific research to the extension of his scientific principles to other fields, where the gains would be greater: 'Ce qui rend les découvertes de ce siècle-ci admirables, ce ne sont pas des vérités simples qu'on a trouvées, mais des méthodes pour les trouver; ce n'est pas une pierre de l'édifice mais tous les instruments et toutes les machines pour le bâtir tout entier' (N.iii.224; *Discours sur les motifs qui doivent nous encourager aux sciences*).

Montesquieu hoped to pioneer the study of the social sciences in a manner which would not be harmful to religion. He aimed to develop a science of society which would be an extension of his views on science, and which would, at the same time, save religion by protecting it from extinction by an advancing mechanistic scientific method. At the same time, he hoped to synthesise the rationalism of his science, and of his religion, with a newly discovered empirical approach. It is no wonder that he considered the twenty years he claimed to have spent on *L'Esprit des lois* were not enough for so grandiose a task (N.ii.97; *Pensées*).

Montesquieu's concern with climate represents an extension of his early belief in ferment. Whereas the emphasis earlier was on the life force in matter, which takes shape through the air outside, Montesquieu now reversed the emphasis to a more empirical concern with outside conditions[22] and away from his earlier

[22] from 1705 on, air was being studied by members of the Académie des sciences; R. Mercier, 'La Théorie des climats des Réflexions critiques à L'Esprit des lois', *RHL* (1953), liii.164.

spiritualist preoccupations. Thus climate, or environment, represented a further securalisation of the idea of ferment, to bring it more into line with the type of empirical approach which he encountered in England and which influenced him so much[23]. Montesquieu hoped to employ the idea of climate both to synthesise his views on science and to establish them on a firmly empirical basis. Towards this end he developed a relationship between each of the sciences and the notion of climate. For example, heat, a warm climate, is employed as an explanation of population increase. He claimed, as regards China, that: 'Il faut que la constitution du climat de ce pays favorise la génération' (N.ii.97; *Pensées*). Again, he argued that the ferment or life force which is contained in the earth, in matter, emerges to form animals, plants or rocks, a state of affairs which is determined by the climate of the country. Finally, the tremendous variation of the species is now seen as being environmentally controlled (N.ii.34; *Pensées*).

Montesquieu's views on science were again reflected in the idea of law which he expounded in *L'Esprit des lois*. The laws he had in mind were scientific and not juridical[24]. Further, Montesquieu made a distinction between pre-social unchanging laws, and those which can be changed, thus disminishing the uncompromising rigidity specified by Newton. The laws which interested Montesquieu most were relative to the society, and so could not be considered to be unchanging[25]. He wanted a change in emphasis from the letter of the law, as set down in Newtonian science, to the spirit of the law, as set down in his own work. This change in emphasis was a logical result of his rejection of the 'fixiste' Voltairean universe, to one which was subject to fundamental change.

The god of Newton and of Voltaire not only created the universe and interfered in its operation, he also determined that the

[23] R. Shackleton, *Montesquieu*, p.117, refers to his time in London as: 'The most important period of his life'.

[24] *ibid.*, p.245.

[25] sir Courtenay Ilbert, *Montesquieu*, p.18: 'The relativity of laws, that is Montesquieu's central doctrine'.

universe would obey rigid and unchanging laws, which had at last been established by Newton. By positing a constantly changing universe, Montesquieu opened the way for a science which is contingent, not absolute, one which is relative, not final. It is little wonder that Voltaire was amused by mme Du Deffand's ironic quip that the book should be called *De l'esprit sur les lois* rather than *L'Esprit des lois*[26]. The laws which regulated Voltaire's own universe were so diminished by Montesquieu as to be little removed from a completely free universe, in the sense of one which is changing all the time.

Montesquieu's science made two major contributions to his politics: the idea of climate as being an important determinant, and the argument that laws of politics should be like laws of science. Within the context of Montesquieu's point of view, these were both radical ideas. As matter is changing constantly, adjusting government to suit leaves plenty of scope for change. Similarly, the idea of a political condition where men make laws as they are needed, and based on facts, which are taken to be contingent, and which change rapidly, gives Montesquieu every claim to being the father of political science.

If Montesquieu's postulate of matter in flux is not accepted, however, and if it is considered that the climate changes little if at all from one century to the next, his system will then have conservative implications. In this case government, once it conforms in an appropriate way with climate, cannot be changed. This was not Montesquieu's view of the matter. The laws which interested Montesquieu most were relative to the needs of the society, and developed in an environment which was changing all the time. Montesquieu's distinction between climate and moral determinants in *L'Esprit des lois* stands for his distinction between science and his thought on other matters. This raises the important question of the importance of science in his scheme of things. Whether he gave primacy to moral or physical factors in *L'Esprit*

[26] K. Martin, *French liberal thought in the eighteenth century*, p.150.

des lois is arguable[27]. The likely answer is that he gave rein to his naturalism when it was ethically and politically innocuous, but his humanistic and religious ideas triumphed whenever the issues were important[28]. The result was to ensure more and more that the relative laws would triumph over the absolute ones. Man, by the use of his ability to make political laws like laws of science, would eventually free himself almost completely from the dominance of climate.

It was Rousseau, far more than Edmund Burke, who understood the spirit of Montesquieu's laws. *Du contrat social* represents Montesquieu's political principles carried to their logical conclusion. Montesquieu, *président à mortier* of the *parlement* at Bordeaux, and baron de La Brède, put restrictions on his principles to suit his own condition. Rousseau, who had nothing to lose, appreciated the radical significance of the use of the life sciences as a rationale in politics. He worked from the equality of one life with another, which is implicit in Montesquieu's work, and explicit in his science, to develop his most important achievement in politics, *Du contrat social*, on which the 'thèse democratique' depends.

Montesquieu's attempt in *L'Esprit des lois* to synthesise a rationalist and an empirical approach as they refer to society, established his reputation as a scholar of the first order[29]. He was a pioneer not only in social analysis, but was trying, at the same time, to reconcile this with ethical preoccupations. He hoped to save religion by establishing it on the basis of an alternative science to that of the mechanists. It is perhaps symptomatic of our own times that his work in the application of science to the study of society is remembered long after his religious preoccupation has been completely forgotten.

[27] H. Vyverberg, *Historical pessimism in the French enlightenment*, p.167, emphasises Montesquieu's 'insistence upon environmental determinism'. J. Dedieu, *Montesquieu*, p.138, argues the opposite.

[28] L. G. Crocker, *An Age of crisis*, p.93.

[29] R. Shackleton, *Montesquieu*, p.319.

CHAPTER 6

Science and progress

The cardinal debt of the *philosophes* to the writers of clandestine manuscripts of the first half of the eighteenth century was their rejection of the doctrine of original sin[1]. This opened the way for the development of ideas of progress. To the Christian, a major barrier in the way of improvement is man's fallen nature, which sets limits to his capacity to progress. If man were not limited by his own imperfections, it would only remain for improvements to be thought of and efforts would be made to achieve them. It is in this manner that the rejection of the doctrine of original sin opens the way for the idea of progress.

All the *philosophes* believed, one way or another, in the idea of progress which, as they saw it, makes for happiness on earth. They differed in their views of how progress, the happy life, is to be achieved. The proponents of the life sciences emphasised feeling, so that the cult of *sensibilité* was exaggerated to a point where Diderot, if he saw a fine, natural painting, would weep[2]. Their key concern was for a life that is happy, for *bonheur*[3], which derives in the first place from the fact of existence, and depends on the simple satisfaction of the physical senses. As life matters most, so *amour-propre* is the basic impulse in man. The supporters of the life sciences aimed to replace the age of glory with the cult of happiness, which is achieved through the family, and friendship, and in the natural surroundings of the country[4].

[1] I. O. Wade, *The Clandestine organisation*, p.272.

[2] A. M. Wilson, *Diderot. Testing years 1713-1759*, p.329.

[3] R. Mauzi, *L'Idée du bonheur au XVIII^e siècle*, p.329.

[4] R. Mauzi, pp.620, 484, 374.

The proponents of the physical sciences had their own cult of happiness, through reason. Here satisfaction comes not from mere sensation, but from reflection on it. The senses supply the raw material from which the mind draws its own conclusions. The emphasis is on reason, not feeling. Here happiness derives from study[5] and analysis, through the controlled life of Voltaire at Ferney, through self-control, and right order.

These two positions, though seemingly similar, are in fact substantially different. The argument between them raged throughout the eighteenth century during which time the balance shifted to the side of the advocates of feeling.

One of the most curious forms of the conflict between these two points of view centred on the garden. In the course of the eighteenth century, the French garden, geometrically ordered, in linear, mathematical proportions, was assailed by the English garden, diffuse and disordered. As one commentator puts it: 'Au jardin français se substitue le jardin anglais, sentimental, qui est ordonné pour parler au cœur, suggérer des émotions, douces, mélancoliques, "romantiques".'[6]. The origins of romanticism can be seen in the French Enlightenment, in particular, amongst the supporters of the life sciences. It was done in the name of England, so that *Pamela* and *Tom Jones* were widely read by the intelligentsia of the day[7], and praised, for example, by Diderot (A.-T.v.211-227; *Eloge de Richardson*).

The debate on happiness raised the problem of how it might best be achieved. This was the issue between the 'ancients' and the 'moderns' which provided the battle ground where the idea of progress was shaped[8]. Is progress, or happiness, to be achieved by going back, or does the golden age lie in the future?

[5] *e.g.* C. Helvétius, *Epître sur l'amour de l'étude*; *Œuvres*, iii.147.

[6] G. Lanson in *RHL* (1908), xv.168.

[7] D. Mornet, 'Les Enseignements des bibliothèques privées 1750-1780', *RHL* (1910), xvii.461.

[8] H. Baron, 'The Querelle of the ancients and the moderns as a problem for renaissance scholarship', *JHI* (1959), xx.3-22.

The upholders of the physical sciences were normally classicists who championed the art of the past[9]. It was in this sense that Voltaire wrote his many plays extolling the culture of Greece and of Rome[10]. Here it was less their views on science than their hostility to Christianity that was at work. It was in this mood that Gibbon wrote his *The Decline and fall of the roman empire*[11]. Science, from this point of view, was an exception to the rule. It provided the one area in which progress had in fact occurred, which made the contrast all the greater.

The classical view of man was still as true for Voltaire as when it was first set down. This followed from his belief that man has not changed. To emphasise the timeless quality of true art, Voltaire wrote his plays in the style of the classics, and employed Rameau to write his harmonic mathematical-type music to accompany them (*e.g.* M.iii.117-156; *Samson*).

While the proponents of the life sciences also favoured the study of the past, they were far less influenced by it. It was because degeneracy had set in that the classics, written at a time when art was more naturalistic, should be studied at all. Neither Rousseau (R.xii.94; *Réponse au mémoire anonyme*), nor Diderot (A.-T.xv.82), favoured a slavish imitation of the past. Unlike Voltaire, they did not write in the shadow of the classics. When Alembert, on behalf of Voltaire, upheld classical-type plays, in his article 'Genève' in the *Encyclopédie* (vii.578-582), Rousseau reacted so violently in his *Lettre à m. d'Alembert sur son article Genève* (R.ii.1-220) that Alembert chose the opportunity thus provided to resign from joint editorship of the *Encyclopédie*. It followed logically from Rousseau's belief in change that the most any play can be is true at the time it is written, not universally true. Man has changed fundamentally, so that it is pointless to adhere rigidly to the classics as being better than present work. The test of art is whether or not it is true to nature, not its timelessness.

[9] D. Mornet, 'La Question des règles au XVIII[e] siècle', *RHL* (1914), 241-268, 592-617.

[10] *e.g.* M.vi.15-85, *Rome sauvée*; M.vi.357-435, *Tancrède*.

[11] see especially vii.338.

Like Diderot, he favoured a naturalistic art, the purpose of which would be to examine simple present-day topics. Diderot's *Le Père de famille* was in this vein and was a success in its day[12]. In the second half of the eighteenth century, while the popularity of the theatre was continuing to increase[13], victory swung to the naturalists: 'L'ancien idéal d'ascétisme, d'austérité, fait place à un idéal de bonheur, de plaisir, de jouissance'[14]. In sharp contrast, Rousseau, and those who thought like him, saw little or no progress in science. If anything, the sciences were resulting in degeneracy, not progress. All that any science can be is true in its own day, not universally true. He did not wish to free himself from the dogma of the churches to fall victim to the universalism of the scientists.

The debate between the ancients and the moderns opened the way for the idea of progress by breaking down the authority of the past. Bury[15] has rightly noted that the idealisation of the past, a legacy from the Renaissance, was a bar to change. It was the proponents of the physical sciences, by their contribution of the idea of advance in science, and the supporters of the life sciences, by their rejection of the authority of the past, who between them reversed the position, and made it possible for a new synthesis to appear. Neither side could, on its own, develop a fully-integrated doctrine of progress, because each had some misgivings. It was not until towards the end of the century that Condorcet was able to arrive at a synthesis. Before this could be done, an appropriate sub-structure had to be generated to under-pin the idea of progress.

The crucial importance of utilitarianism, the principle of the greatest happiness of the greatest number, was that it represented a dynamic factor from which, it seemed, progress would result.

[12] A. M. Wilson, *Diderot. The testing years 1713-1759*, p.322.

[13] L. Bourguin, 'La Controverse sur la comédie au XVIII[e] siècle' *RHL* (1920), xxvii.568.

[14] L. Bourguin, *op. cit.* (1919), xxvi.572.

[15] J. B. Bury, *The Idea of progress*, p.67.

The difficulty in developing this point of view into a fully integrated system arose, apart from inherent difficulties in this as a solution, from the fact that its exponents were divided amongst themselves. These very differences, however, acted as a spur to invention.

The *philosophes* were all agreed on the rejection of otherworldliness, which leaves only this world to be enjoyed. How can this be achieved? The supporters of the physical sciences upheld mathematics as the method of deriving the greatest happiness. A sort of felicific calculus was to do the trick. This was the position, for example, of Helvétius. Conversely, the proponents of the life sciences favoured the idea of a legislator, a human being on whose judgment the whole thing would depend. This was the position, for example, of Rousseau and of Diderot. Each assailed the claims of the other. Voltaire showed how there was gross injustice within the law, the implications of which he clearly drew out in his analysis of the cases of Calas, Sirven and La Barre[16]. To rely on a just legislator was obviously a chimera. Diderot, on his side, assailed the mathematical proposals of Helvétius (A.-T.ii.267-456; *Réfutation*).

The *philosophes* are important less because they initiated a debate on progress than because they developed one which they inherited. They re-stated the controversy between Bayle and Leibniz[17] and put it on a new footing. The point at issue between Bayle and Leibniz was the degree to which reason can triumph over the passions. They were both in agreement that the possibility of progress depends on the triumph of reason. Where they differed most significantly was that Leibniz had more faith than did Bayle in the strength of reason in mankind. While Voltaire, and those who thought like him, accepted the debate as inherited from Bayle, the proponents of the life sciences,

[16] P. Gay, *Voltaire's politics*, pp.273-308.

[17] for a discussion of the debate refer W. H. Barber, *Leibniz in France: from Arnault to Voltaire*, pp.58-89.

especially Diderot, while they acknowledged their debt to Leibniz, took the debate far further than he had.

The belief in progress gained from the line of thinking of Leibniz more than from that of Bayle. There was an optimistic note in his view that this is the best of all possible worlds[18]. While Leibniz's optimism could be developed in a conservative direction, as it was, for example, in Pope's *Essay on man*, where he argued that 'whatever is, is right', more typically it made for change. The essence of the philosophy of Leibniz is the belief in the power of human reason to resolve the important problems[19]. As the mind of man is a powerful instrument, so progress in all fields is certain to follow. Conversely, pessimism follows logically, though not necessarily, from a lack of confidence in the power of reason in men. Accordingly Bayle, who was a pessimist, believed that man's reason is weak, limited by the strength of his passions. As a result, he discovered a conflict between faith and reason, between Revelation and what man can discover for himself, between what is expected of man, and what he has in fact achieved. Bayle started out by postulating that man's welfare is the sole object of creation[20]. From here it was a short step to showing how different is the actual world from what god intended. It followed that there must be a tremendous gap between faith and reason, between what god wants and what man has achieved. Optimism was clearly unjustified.

It seemed to Leibniz that Bayle had undermined religion by treating faith and reason separately. It was to rectify this position that he published his *Théodicée* in 1710. In it he rejected Bayle's idea of man's weakness and argued for the freedom of the will. Working against the idea of progress is the notion of evil. If man's reason is relatively powerful, any evil tendencies can be controlled. If man's will is free, as Leibniz argued, progress is relatively easier than if his will is in bondage. As the rôle of reason is

[18] *ibid.*, p.80.
[19] G. Martin, *Leibniz*, pp.8-20.
[20] W. H. Barber, *Leibniz in France*, p.84.

disminished, the problem of the power of evil appears. In the argument between Bayle and Leibniz, the rôle of reason and of evil varied inversely with each other. Bayle was so impressed by the fact of evil that he agreed with the sense of the Manichean position, that there exist two opposing principles of good and evil, both of which determine the fate of man. The accuracy of this, he argued, depends on observation. The only weapon we have against the Manichean position is not reason, which favours it, but revelation, which rules it out, because it requires one almighty and beneficent god.

While revelation resolved the problem posed for Bayle by Manicheanism, of the power of evil, it created a new one, namely, how to explain the existence of evil. This problem, he believed, cannot be solved by reason: '1. La lumière naturelle et la Révélation nous apprennent clairement qu'il n'y a qu'un Principe de toutes choses; et que ce principe est infiniment parfait. 2. La manière d'accorder le mal moral et le mal physique de l'homme avec tous les attributs de ce seul Principe de toutes choses infiniment parfait, surpasse les lumières philosophiques, de sorte que les objections des Manichéens laissent des difficultez que la raison humaine ne peut résoudre'[21]. Bayle pointed out how ironic it was that the Manicheans could explain the facts with their wrong hypothesis, while Christians with their right postulate could not.

His belief in the power of evil plunged Bayle into pessimism[22]. Men would always be fearful and would err. Human nature would not change. Bayle had no hope for a future in any way better than the past. Even while he strove to improve the human condition, to throw light in dark places, he saw himself as having little influence on the position as a whole. He had raised the problems of evil, and of man's freedom, but he had not been able to resolve them. These remained key issues in the Enlightenment in eighteenth-century France.

[21] *Réponse par m. Bayle à m. Le Clerc; Œuvres diverses*, iii.1006.

[22] E. Labrousse, *Pierre Bayle*, ii.346-386.

In the works of the *philosophes*, the names of Leibniz and of Bayle became slogans in a party war about the possibility of progress. The result was a revival of the science of Leibniz. At the same time, there was a growing interest in Bayle's *Dictionnaire*, which featured largely in eighteenth-century thought. Throughout the century, increasing numbers of people queued outside the Mazarin library to consult the *Dictionnaire*[23]. The reading public also showed evidence of a developing preoccupation with history. Over a quarter of the books held in eighteenth-century French libraries were works of history[24].

As the rationale for progress was shifted from the historical method of Bayle and the philosophy of Leibniz to the firmer base of the physical sciences and the life sciences, the debate took on a wholly different character. All that remained were the names of Bayle and of Leibniz, and those parts of their work which the philosophes wished to retain. The historical method of Bayle was praised and imitated by Voltaire. On the other hand, the proponents of the life sciences placed less emphasis on history. Accordingly, a major difference between Bayle's *Dictionnaire* and the *Encyclopédie* of Diderot was that the importance of the study of history had suffered a reverse, while the life sciences and technology gained greatly. The thought of the Enlightenment is here seen as a debate between proponents of the physical and of the life sciences where, as the century advanced, victory passed to the latter. In time, more was heard of nature and less of reason[25]. Even then, the reason that survived was not in the Cartesian sense of an ability to judge about a complexus of god-given ideas, but in the Lockean meaning of a power to judge correctly about sense experience[26].

[23] A. Wolf, *A History of science, technology and philosophy in the eighteenth century*, i.38.

[24] D. Mornet, 'Les Enseignements des bibliothèques privées 1750-1780', *RHL* (1910), xvii.449-496.

[25] J. Roger, *Les Sciences de la vie*, p.448.

[26] R. Z. Lauer, *The Mind of Voltaire*, p.3.

On the question of progress, as elsewhere, the division is between those who employed the physical sciences as a rationale, compared with those who supported the use of the life sciences to develop their beliefs. The use of the physical sciences worked for a doctrine of progress from the past, but with little potential for additional gains. The use of the life sciences was best matched to a belief in a degenerate present with progress in the future. The classical statements of these positions can be seen in the work of Voltaire and of Rousseau respectively.

Voltaire's belief in progress was powerfully reinforced by his science. His proof of the existence of god, that he made the world in its present shape, depended on the mechanist concept of a static universe. Progress occurs as men increase their knowledge of an unchanging world. While he rejected moral progress, Voltaire accepted intellectual advance[27]. The result is cumulative: knowledge can be handed down, and can be increased by each generation. Newton's statement: 'If I have seen further than most men, it is by standing on the shoulders of giants'[28] exemplifies the idea of progress involved. It followed from Voltaire's concept of linear progression that the age of Louis XIV represented an advance on anything that came before (M.xxvii.11-40; *Siècle de Louis XIV*). From here it would appear as if Voltaire might well have gone on to argue for a condition of continuous progress, as man discovers more and more about his universe. This was not to be. While his science strengthened his belief in progress, it did not help him to resolve the problem of evil, and this severely restricted his doctrine of improvement. Voltaire's 'fixiste' universe, which his science encouraged, raised a problem: as god made the world in its present shape, how does evil arise? Is god, who is the author of everything else, responsible for evil?

The problem arose in the first place from Voltaire's rejection of the doctrine of original sin, which is employed to explain the

[27] H. T. Mason, *Pierre Bayle and Voltaire*, p.61.

[28] quoted by E. N. da C. Andrade, *Isaac Newton*, p.49.

existence of evil. To allow this doctrine would offend against Voltaire's view that men are as god made them, no better, no worse. Alternatively, he had to face the possibility that god is the author of evil, something which it is difficult to accept. He never satisfactorily resolved the problem of evil[29], which set limits to his idea of progress. His failure found its characteristic expression in *Candide*, which was aimed at the optimism of Leibniz, and in his *Poème sur le désastre de Lisbonne* (M.xv.47-55), which was aimed at the happy optimism of the catastrophists who, like Rousseau, saw god's hand in such occurrences. Voltaire's difficulty with the problem of evil gave rise to a pessimism which increased as he grew older. More and more, he was forced to rely on the negative doctrine that the way to achieve improvement was through the destruction of the Roman Catholic church. Voltaire's belief in progress, which depended for its rationale on his science, rested uneasily with his inability to resolve the problem of evil.

Yet all the *philosophes* believed, more or less, in progress. This was a logical consequence of their dismissal of the Christian doctrine of original sin. There was, however, a marked contrast between the views of those *philosophes* who rationalised the belief in progress in terms of the physical sciences, compared with those who used the life sciences. The rationale in terms of the physical sciences resulted in a simple linear progression, where things get better. Conversely, there was the belief of the proponents of the life sciences, that the golden age lay in the past. Here the rejection of the doctrine of original sin gave rise to the belief that man in the state of nature is better and happier than in a civilised condition[30]. This resulted in the cult of the noble savage, which encouraged an interest in books on travel.

Rousseau provides the best example in the Enlightenment of the cult of nature. In *Discours sur cette question: le rétablissement des sciences et des arts a-t-il contribué à épurer les mœurs* (R.i.1-47),

[29] H. T. Mason, p.76.

[30] I. O. Wade, *The Clandestine organisation*, p.272.

he argued that science has resulted not in progress, but in degeneration. This happens when men pretend to gain knowledge about the world around, and set up systems, all of which are bound to fail. Such systems may, at most, be right for the present, but they are a denial of the fact of constant change in nature[31]. Rousseau rejected as false the Voltairean idea that knowledge can be passed on from one generation to the next, and still remain appropriate. Constant change in nature ensures that what was true of it yesterday will not be true tomorrow. Rousseau's support of ferment, the belief that god establishes his existence by the incorporation of a life force in matter, involved the idea that man in the state of nature is good, is close to god and to happiness. This is the condition of *bonté*. If men want to progress beyond that, however, they must move into society, when *vertu* becomes possible. But with the chance of moral growth comes the probability also of degeneration. *Du contrat social* is a measure of the price men must pay if they want to progress.

The problem of evil did not exist for Rousseau in anything like the same form as for Voltaire. Man in the state of nature cannot be evil. How, then, does evil arise? Rousseau moved the responsibility for it from man to society. An example of how things go wrong in society, when men get together, can be seen in the sciences. They become divorced from nature and develop through the generations false systems, such as, for example, absolute space and absolute time, which are rationalist, but which do not square with the facts. Man in society, not god, nor man in the state of nature, is responsible for the development of evil. If this development is to be prevented, stern legal measures are required. The task of the legislator is set out in the *Contrat social*. Where can such a man be found? Rousseau's answer was that if he had the opportunity to legislate, he would have no need to write about it[32]. He was ready for the task: 'On me demandera si je suis prince ou législateur pour écrire sur la politique. Je réponds que non, et

[31] F. Vezinet, 'Rousseau ou Diderot?' *RHL* (1924), xxxi.306-314.

[32] R. Polin, *La Fonction du législateur chez J.-J. Rousseau*, pp.231-248.

que c'est pour cela que j'écris sur la politique. Si j'étois prince ou législateur, je ne perdrois pas mon temps à dire ce qu'il faut faire; je le ferois, ou je me tairois' (R.vi.3; *Du contrat social*).

Comparing these two views of progress, it becomes clear that one depends for its success on man's ability to reason, whereas the other relies on his feeling, the natural goodness of the life force in him. Diderot, who, like Rousseau, relied on the general will to achieve improvements, also recognised the strength of the life force, expressed through the passions: 'Nous autres, nous sommes tous enfants de la passion' (*Correspondance*, ed. by G. Roth, iv.151).

The problem for the proponents of the life sciences was that, although they fought for progress in the name of Leibniz, against Voltaire's championing of Bayle, they could not avail themselves of Leibniz's optimism. For Leibniz, progress is possible through reason, which apprehends knowledge about an unchanging universe. This position could not be adopted by Rousseau or Diderot. They believed in a universe which is changing all the time, so that reason can tell us little about it. They championed naturalism rather than rationalism. Indeed, Rousseau believed that man's tendency to rationalise leads him away from the truth, which is sensation. It transpired that the problem of evil, inherited from Bayle, stood in the way of a doctrine of progress. For the proponents of the physical sciences, evil was represented by the strength of the passions, which lead men astray, and which cannot be diminished. The proponents of the life sciences did not deplore the passions, but saw in man's pride, a product of his reliance on reason, the chief barrier in the way of progress.

It was in *L'Esquisse d'un tableau historique des progrès de l'esprit humain* of Condorcet, that the idea of progress found its most integrated expression. Condorcet's achievement was to synthesise two strands of opinion, one founded on the life sciences, the other on the physical sciences, and to thereby develop the most important statement generated in the Enlightenment of the doctrine of progress. Coming late in point of time, Condorcet was in

a better position to synthesise than were his predecessors. He was almost too late, as the crisis of the French revolution was at hand. The reaction that came after it bred a distrust of Enlightenment thought which acts as a retarding factor in any consideration of the points at issue.

Up to 1770, Condorcet relied on mathematics and on the physical sciences to uphold his opinions. This began when he drew the attention of Alembert, and, through him, of Lagrange, by his *Essai sur le calcul integral*, which was published in 1765. The result was an invitation to join the Académie des sciences in 1769[33]. The backing of Alembert and of Lagrange won him the position of perpetual secretary in 1773. It was through Alembert that Condorcet met Voltaire, an influence which, together with that of his own early mathematical training, was apparent in his idolisation of Newton. What mattered to Condorcet was the scientific method proposed by Newton and extolled by Voltaire, the use of inference from facts, made possible by measurement, or quantification: 'Mais Newton fit plus, peut-être, pour les progrès de l'esprit humain, que de découvrir cette loi générale de la nature; il apprit aux hommes à n'admettre, dans la physique, que des théories précises et calculées, qui rendissent raison non seulement de l'existence d'un phénomène, mais de sa quantité, de son étendue' (CE.176). It was proposed by Condorcet that human reason would resolve the important problems: 'C'est au nom de la raison considérée comme un absolu que d'Alembert et Condorcet protestent contre les privilèges de l'Eglise et de la Noblesse'[34].

Condorcet worked from within similar parameters to Voltaire, but reached different conclusions. For both of them the universe is unchanging. This makes it possible to pass on information from one generation to the next, which is progress as far as knowledge is concerned: 'On doit à Newton et à Leibnitz l'invention de ses calculs, dont les travaux des géomètres de la génération prédédente

[33] J. Boissounouse, *Condorcet*, p.15.
[34] M. J. Laboulle, 'La Mathématique sociale: Condorcet et ses prédécesseurs', *RHL* (1939), xlvi.44.

avaient préparé la découverte' (CE.176). Where Condorcet differed from Voltaire was in their respective attitudes to evil. Unlike Voltaire, Condorcet achieved an integration of reason with the passions. He did this by rejecting the view of the passions as wrong, so that evil itself was discarded as not an essential part of the human condition. Condorcet was indebted for the reinstatement of the passions to the arguments of the proponents of the life sciences. Friendship with Turgot resulted in his conversion to the beliefs of the physiocrats[35]. Condorcet acknowledged the debt in his *Vie de Turgot* (C.v.5-233) where he referred to Turgot as: 'Celui qui, peut-être, a été le moins éloigné de la perfection à laquelle la nature humaine peut s'élever' (C.v.233).

In 1770, in his *Requête à tous les magistrats du royaume*, Condorcet championed the physiocrat cause. The belief of the physiocrats, that value comes from the earth, derived from the ferment theorists' emphasis on the life sciences. It was no accident that Quesnay, the first to formulate a physiocratic doctrine, was a medical doctor who started out as a biologist. His *Tableau économique* published in 1758 established his claims as a physiocrat.

While support of the life sciences made for democracy in politics, it worked, in economics, for the beliefs of the physiocrats. This transition was achieved in the thought of Turgot, and found its apologist in Condorcet. Their thinking was oriented to economics as well as to politics. Diderot, Rousseau and Montesquieu, however, stopped short of economics. This difference was to foreshadow the division between the Girondins and the Jacobins, which was to result in the persecution and death of Condorcet in 1794. The physiocratic economic doctrine was compatible in politics with either the 'thèse royale' or the 'thèse démocratique'. Diderot, for example, was greatly influenced during the 1750's and the early 1760's by Quesnay's views, and had him make contributions to the *Encyclopédie*[36]. He could see

[35] J. Bouissounouse, pp.37, 47.

[36] A. M. Wilson, *Diderot. The testing years 1713-1759*, p.184.

the radical implications of the idea. Turgot, on the other hand, clearly integrated the doctrine with the 'thèse royale', and it was in this form that Condorcet first encountered it.

Condorcet switched, during his life, from support of the 'thèse royale' to the 'thèse démocratique'. It was his growing humanism that was responsible for the change: 'Le sentiment de l'humanité, c'est-à-dire, celui d'une compassion tendre, active, pour tous les maux qui affligent l'espèce humaine' (CE.164). Condorcet was president of the Anti-slavery association, and the author of *Réflexions sur l'esclavage des nègres* (C.vii.61-140). He was also a powerful supporter of feminism, so that his thinking was likely to find its rationale in the democratic bias of the life sciences, more than in the use of the physical sciences, as a rationale for his politics. The emphasis on vegetable and animal life, on organic growth, as an analogy for progress, signalised a change in orientation in his thought generally: 'La perfectibilité ou la dégénération organiques des races, dans les végétaux, dans les animaux, peut être regardée comme une des lois générales de la nature' (C.vii.236).

Notwithstanding this change, Condorcet never denigrated the physical sciences. What he attempted was a synthesis of the two traditions. He borrowed from the physical sciences the emphasis by its proponents on reason. He took from the life sciences a stress on the importance of the passions in human affairs. This broadening of his scientific interests was made easier for him through being secretary of the Académie des sciences where he was required to write eulogies of the scientists as they died, regardless of their points of view (C.ii.1-670, iii.1-566).

The result was a synthesis of reason and passion, and the use of both the physical sciences and the life sciences, to justify a doctrine of progress. Voltaire's pessimism about evil, due to the strength of the passions, which he saw as a bar to progress, was removed. The passions were now on the side of reason. Rousseau's fear that social living can corrupt the passions was also defeated by retaining a powerful rational self-control in men.

Behind all of Condorcet's statements on knowledge and virtue lies the optimistic assumption that, when given a free choice between truth and error, men will invariably choose the truth[37].

Rousseau saw a bar to progress in intellectual pride, due to excessive reliance on reason. He believed that men in society make up rules as if they live in a static universe, thus denying change. This comes about through knowledge being handed down. Condorcet's science overcame Rousseau's objection by allowing a larger rôle to reason, because, by postulating a universe which is rational, it becomes feasible to gain knowledge of it far more readily than is otherwise the case.

Condorcet believed in unlimited progress, that man would go on to discover more and more about the universe and his place in it, and that moral development would result: 'Enfin, on y vit se développer une doctrine nouvelle, qui devait porter le dernier coup à l'édifice déjà chancelant des préjugés: c'est celle de la perfectibilité indéfinie de l'espèce humaine, doctrine dont Turgot, Price et Priestley ont été les premiers et plus illustres apôtres' (CE.166). The characteristic feature of his belief in progress was that man could take an active rôle in achieving it, untroubled by fears of his own limitations[38].

If neither man's passions nor the 'esprit de système' is impeding the process, why in the past has progress been so slow? Condorcet was not stuck for an answer. He believed that it was not anything in man himself, nor something in society, that had slowed the rate of progress hitherto. He blamed a plot by the priests for this state of affairs, which they achieved by use of the doctrine of the double truth: 'Ils eurent donc deux doctrines, l'une pour eux seuls, l'autre pour le peuple' (CE.41).

Condorcet believed that what was needed was to be rid of religion completely. His radicalism far exceeded that of Voltaire so that, on the anonymous appearance in 1774 of the *Lettres d'un*

[37] H. Vyverberg, *Historical pessimism in the French enlightenment*, p.68.

[38] G. G. Iggers, 'The Idea of progress: a critical reassessment', *The American historical review* (1965), lxxi.2.

théologien, Voltaire disassociated himself from it[39]. The growing radicalism of Condorcet, his republicanism, and his fanatically anti-religious attitude, resulted in his having little in common with Voltaire. He had never associated with Diderot or Rousseau.

The rejection of the doctrine of original sin had thereby opened the way for progress, limited for Voltaire by man's nature, for Rousseau by the nature of society, but unlimited for Condorcet, once he had integrated nature and reason[40]. As far as the idea of progress is concerned, the use of either scientific tradition was not in itself enough to arrive at a fully satisfactory doctrine. It was the achievement of Condorcet to draw on elements of both to establish a belief in progress which, though originally derived by means not scientific, was greatly strengthened by seeming to depend on a scientific rationale.

While the debate on progress was synthesised by Condorcet, the component parts of the synthesis, the belief in the power of reason, and the re-instatement of the passions, were joined in uneasy equipoise. Condorcet's synthesis depends on the proposition that, when given a free choice between truth and error, men will choose the truth. Notwithstanding that this optimistic credo does not seem to square with experience, it has become the basic tenet of all radical thought. Those who have lost their faith in god place it in man. This in turn is an act of faith rather than a statement of fact. As such it can neither be proven nor disproved.

The conclusion drawn from this analysis is that the debate on progress, initiated in its modern form in the French Enlightenment, has not been resolved. The issues so raised still stand.

The debate on progress had as one of its chief results the emancipation of women. Those who gained in turn disseminated the doctrine of progress, which eventually won widespread credence. The emphasis on passion, a derivation of reliance on the life sciences, works for feminism. If the passions are to be

[39] J. Boissounouse, *Condorcet*, p.50.

[40] R. Mauzi, *L'Idée du bonheur au XVIII^e siècle*, p.575.

extolled, the result is bound to be the re-instatement of women. The democratic tendency of the life sciences worked in the same direction. In this vein, Diderot admitted to sorrow for women, who should be treated more equably, but who were not in fact so treated (A.-T.ii.258; *Sur les femmes*).

By diminishing the rigidity of laws, and by his emphasis on the importance of matter, and of self-interest as a basis for an individual's actions, and by his support of a modified version of Bonnet's ovism, Montesquieu worked for both a new emphasis on the importance of the passions and for the re-instatement of women[41].

At the same time, the proponents of the physical sciences also worked, though to a less degree, for the re-instatement of women. Women, like men, were freed of the burden of original sin. However, their position was taken to depend on what was considered reasonable for women, not on a doctrine of equality, nor on an idealisation of feeling. While the salon culture of eighteenth-century Paris worked for the re-instatement of women, and of the passions, it also reflected the divisions that existed amongst the philosophes. The rivalry between the salons of mme Geoffrin, on the one hand, and those of mme Du Deffand and mlle de Lespinasse on the other, was an important fact of social living in eighteenth-century Paris[42]. Taken together with the salons of mme de Tencin and de Lambert, these were the most important salons in the sense that the most influential of the philosophes passed through them.

The rivalry between mme Du Deffand and mme Geoffrin reflected, amongst other things, differences between the proponents of the physical and the life sciences respectively. The growing popularity of the life sciences was seen in support not only for the salon of mme Geoffrin, but in the development of the

[41] J. P. Zimmermann, 'La Morale laïque au commencement du XVIII^e siècle' *RHL* (1917), xxiv.42-64, 440-466.

[42] R. Picard, *Les Salons littéraires et la société française 1610-1789*, ii.250.

salon of mme de Lambert, and that of mme Geoffrin's close friend, mme de Tencin[43]. Montesquieu visited both the latter salons, and was a habitué of the salon of mme de Lambert[44]. Quesnay also visited the salon of mme Geoffrin, who was a friend of mme de Pompadour[45].

The proponents of the physical sciences at first attended the salon of mme Du Deffand. With time, their interest swung from the ageing widow to her niece and protégée, the passionate mlle de Lespinasse[46]. When she was evicted for holding court on her own, those whom she described as her two secretaries[47], Condorcet and Alembert, went with her. There was a degree of prejudice in the change. Mme Du Deffand was a proponent of Cartesian scepticism[48] which she carried to excessive lengths: 'Ne parlons plus du bonheur, c'est la pierre philosophale qui ruine ceux qui la cherchent' (*Correspondance*, ed. by M. de Lescure, i.301). Mme Du Deffand's scepticism[49] ended in pessimism: 'Je n'ai . . . qu'un malheur, c'est la douleur d'être née' (*Correspondance*, ii.339). Mlle de Lespinasse, on the other hand, was dedicated to the same cause as Voltaire: 'Il n'y a que la gloire de Voltaire qui pourrait me consoler de ne pas être née Anglaise'[50].

While it is often recognised that the salons promoted their champions at the expense of orthodox believers, what should be appreciated also is that they were in competition with each other. Fontenelle, who reigned supreme at the salon of mme de Lambert, introduced Montesquieu there, and used his influence to gain admission for Montesquieu to the 'Académie des sciences' in 1724[51].

[43] *ibid.*, ii.202.

[44] R. Shackleton, 'Montesquieu' in *Pierre Bayle*, ed. by P. Dibon, p.145.

[45] M. Roustan, *The Pioneers of the French revolution*, pp.87-88.

[46] P. Bonnefon, 'Mademoiselle de Lespinasse', *RHL* (1897), iv.321-365.

[47] *ibid.*, p.344.

[48] R. Picard, *Les Salons littéraires et la société française 1610-1789*, ii.202.

[49] D. Mornet refers to her as one 'Qui ne croit à rien pas même au plaisir' in *Les Origines intellectuelles*, p.54.

[50] quoted by H. Kohn, 'France between Britain and Germany' *JHI* (1965), xvii.283.

[51] R. Shackleton, *Montesquieu*, p.56.

Mme de Tencin, who secured a cardinal's hat for her brother, successfully championed Marivaux against Voltaire for an academic chair[52]. Though the mother of Alembert, whom she abandoned at birth, she had nothing to do with him or his friends. She favoured the life sciences instead, as their egalitarian bias fitted well with her extreme feminism. Condillac, who championed a form of sensationalist psychology beloved by the life scientists, was her nephew[53]. She saw sexual morality as a superstition[54], and lived a scandalous life[55]. The rivalry between the salons extended into the Académie française, where, between 1760 and 1770, it is estimated that nine of the fourteen elections were won through the salons[56].

The status of women improved in proportion as the salons gained in influence. So important were the salons in emancipating women that they began to predominate there, to a point where Diderot complained to Sophie Volland of the shortage of men: 'Nous aurions bien des femmes, mais nous n'en voulons point, parce qu'il est trop rare que ce soient des hommes' (*Correspondance*, ed. by G. Roth, vii.159).

The increasing predominance of women in the salons, uncontrolled by any moral scruples, resulted in excesses which were notorious, but which, while they shocked people, worked towards a re-instatement of the importance of the passions. Mme de Lambert was almost alone in retaining a moral conscience[57]. Mme Du Deffand was, for a time, mistress to the regent[58]. The extraordinary love affairs of mlle de Lespinasse, with the Spaniard Mora and, after his death, with the comte de Guibert, were well-known facts[59], as was her rejection of all advances by

[52] G. Deschamps, *Marivaux*, pp.78-79.

[53] J. Dedieu, *Les Philosophes du XVIII^e siècle*, p.311.

[54] D. Mornet in *RHL* (1908), xv.624.

[55] D. Mornet, *Les Origines intellectuelles*, p.54.

[56] *ibid.*, p.125.

[57] L. G. Crocker, *An Age of crisis*, p.300.

[58] R. Shackleton, *Montesquieu*, p.182.

[59] 'deux grandes passions occupèrent la vie de Mlle de Lespinasse et même l'occupèrent ensemble; son amour

Alembert, though they shared the same house[60]. In sharp contrast was mme de Lambert, who lived out the lay morality that she preached[61].

The salons were responsible for the dissemination of many different kinds of knowledge. As regards science, their effect was to promote the life sciences more than the mechanical world view. The salons of mme Du Deffand and, though to a less extent, of mlle de Lespinasse, were more self-consciously for an élite than were the salons which propagated the life sciences. This diminished their impact. They were not inclined to tolerate anything but the best. Montesquieu, who was a poor conversationalist, was ridiculed when he visited, and Diderot felt uncomfortable there[62]. Rousseau did not attend at all[63]. Buffon, who normally attended the salon of mme Necker, and occasionally visited that of mme Geoffrin, was ridiculed on the occasion of a visit to the salon of mlle de Lespinasse. Buffon used the term 'au diable' there which caused a furore[64].

pour M. de Mora et son amour pour M. de Guibert'; P. Bonnefon, 'Mlle de Lespinasse', *RHL* (1897), iv.322.

[60] R. Grimsley, *Jean d'Alembert*, p.103.

[61] J. P. Zimmermann, 'La Morale laïque au commencement du XVIII[e] siècle', *RHL* (1917), xxiv.55.

[62] J. Morley, *Diderot and the encyclopaedists*, i.308.

[63] R. Picard, *Les Salons littéraires et la société française 1610-1789*, ii.310.

[64] L. G. Crocker, *An Age of crisis*, p.300.

CHAPTER 7

The Science of the Enlightenment

It is customary to belittle the science of the Enlightenment while at the same time exaggerating the use made of the scientific method. In reality, the distinction between science and scientific method is of little or no value. In fact, both the *philosophes* and the scientists were tackling much the same problems. The distinction between the study of science and of literature, so clear in our own day, had not yet been achieved. The difference between the *philosophes* and the scientists was that the latter were, for the most part, employing a more rigorously empirical approach than were the philosophes.

Nevertheless, what must be guarded against is the assumption that the thought either of the scientists or of the *philosophes* was characteristically empirical in its orientation. The debate on science, between the life and the physical sciences, was primarily a rationalist matter. From a purely factual empirical point of view, the question of whether the mechanical world view, or the organic interpretation of the life scientists, is appropriate, is irrelevant. Why should the attempt be made to integrate the sciences? What matters to an empiricist is not the development of an integrated science, but the collection of facts, which all have an equal status, and the drawing of inferences from them. The question of whether the life sciences or the physical sciences are more worthy of study then becomes a chimera, a new type of pointless debate to take the place of the old ones.

Notwithstanding that the debate on science was profoundly rationalist, scientific achievement resulted. Advance came about not, as one might expect, merely by the adoption of a more rigorously empirical approach. It came out of the effort to

integrate the life and the physical sciences, from a rationalist attempt to achieve unity.

The chief contribution of the *philosophes* to science was to keep the debate alive. Out of their conflicting efforts to achieve an integrated world view came a disintegration which made for progress far more than would have resulted if agreement had been reached. This is seen most clearly by comparing the achievements in science in France and England in the eighteenth century, when leadership passed from England, notwithstanding the magnitude of the advantage which Newton had given that country. The very extent of his victory worked against further advance.

The stimulus provided by Condillac to Lavoisier, and by Voltaire to Maupertuis, and by Diderot to Alembert, and by Alembert to Lagrange, and by Buffon to Bonnet and Spallanzani, to mention only a few, is only a small measure of the intellectual ferment generated by the debate between the mechanists and their foes, which penetrated through the whole fabric of French thought in the eighteenth century, and which has its echoes in our own day. Once the stimulus they gave to scientific advance is properly understood, the contribution made by the Enlightenment to science is appreciated. For the most part they did not aim to be scientists, in the sense of men carrying out detailed research in a subject. They were busy trying to resolve what they saw as being far more important problems.

The *philosophes* varied in the amount of time they devoted to detailed scientific investigation. Most devoted very little. None of them gave more time to science than did Buffon. With the possible exception of Alembert, no *philosophe* made a greater contribution to science. He is important for many reasons. Although he took sides in the debate on science, coming down on the side of the life scientists, he was not an orthodox supporter of ferment theory. Notwithstanding, his achievement was largely responsible for the triumph of the life sciences over the physical sciences, as far as the reading public is concerned, in eighteenth-century France. He succeeded here by continuing the tradition

initiated by Fontenelle of retaining science as a branch of literature.

Because he stood alone amongst the *philosophes*, with few friends amongst them, warring with Condorcet[1], and not on good terms with Voltaire or Montesquieu, it has not been properly recognised that he was just as committed as they to the controversies of his day. He was unorthodox, and even original, which has been allowed to blur the existence of a debate between proponents of the life and the physical sciences. The massive stature of Buffon, and the fact that he seems to stand apart from the *philosophes*, when combined with his great contemporary importance, makes it necessary to examine his views if only to test the interpretation being advanced of the thought of the Enlightenment.

Buffon's importance was as a systematiser and propagandist for the life sciences. Yet all the early indications were that he would make his mark as a mathematical physicist, as a populariser in France of the work of sir Isaac Newton[2]. His work as a physical scientist won him recognition such that in 1734 he was admitted as a member of the Académie des sciences when only twenty-six years old[3]. In 1740 he translated some of Newton's work under the title of *La Méthode de fluxions et des suites infinies* and added a preface of his own[4].

The first indication that Buffon gave of having moved from extending the mechanical world view to championing the life sciences was in 1749. That was when he published the first three volumes of his *Histoire naturelle*. These three volumes occasioned a sensation when they first appeared. The first edition, though large, sold out in six weeks[5]. Part of the reason for this success

[1] D. Mornet, *Les Sciences de la nature*, p.129.

[2] J. Dedieu, *Les Philosophes du XVIII^e siècle*, pp.434-435.

[3] D. Mornet, *Les Sciences de la nature*, pp.51-52.

[4] E. Ritter, 'Lettres de Buffon et de Maupertuis adressées à Jalabert', *RHL* (1901), viii.651.

[5] P. Hazard, *European thought in the eighteenth century*, p.141.

was the quality of the workmanship. The volumes were written in superb prose, clearly set out and readily comprehensible, and replete with beautiful coloured plates to support the text. The impact Buffon made on public opinion is all the more remarkable when it is realised that up to 1749, though he had written some scholarly works, he was unknown to the general public. The importance of Buffon is not only that his works were more widely read than were those of any of the *philosophes*, but that his works did more to popularise science than did those of any other books written, and published, in eighteenth-century France. An analysis of 500 library catalogues of eighteenth-century France, which was carried out by Mornet[6], showed that 220 of them had copies of one or all of the works of Buffon:

no. of libraries	*author*	*title of book*
220	Buffon	*Histoire naturelle*
206	Pluche	*Spectacle de la nature*
173	Voltaire	*Œuvres*
165	Rousseau	*La Nouvelle Héloïse*
82	Diderot	*Encyclopédie*
76	Rousseau	*Discours sur l'inégalité*

Buffon's chief debt to Newton was for the principle of attraction. It was in recognition of this that he kept a painting of Newton over his own desk at Montbard[7]. Yet instead of extending the Newtonian synthesis so as to mechanise the life sciences, Buffon employed the principle of attraction in favour of the life sciences, and he turned away from the study of the physical

[6] D. Mornet, 'Les Enseignements des bibliothèques privées 1750-1780', *RHL* (1910), xvii.449-496.

[7] O. Fellows, 'Buffon's place in the Enlightenment', *Studies* (1959), xxv. 618.

sciences. In short, Buffon achieved a volte face. What occasioned Buffon to turn from the study of the physical to the life sciences? It is likely that his humanism was responsible[8]. As the mechanical world view was extended, it threatened to engulf man, by leading logically to the man-machine of La Mettrie. Buffon was concerned to guard against the dethronement of man. His science left man the supreme place in nature: 'Tout marque dans l'homme même à l'extérieur, sa supériorité sur tous êtres vivants' (F.ii.48; *Histoire naturelle*).

François Quesnay's influence directed Buffon's mind towards the study of the life sciences. Quesnay was the founder of the physiocratic movement, and an exponent of ferment theory. As the king's physician, he was in a position to introduce his colleague, Buffon, to mme de Pompadour and to Louis XV. They were all instrumental in securing for Buffon the important and influential position of intendant at the Jardin du roi[9]. The result was that Maupertuis, who also applied for the position, did not get it.

The influence of the ferment theorists appears at many points in Buffon's science. It appears most of all in his belief that life, both animal and vegetable, results from fermentation due to heat, and that, as the earth is cooling down, there will be an end to the process[10]. He supported his belief in ferment, or environmentalism, by reference to the fact that different continents have different animals (*e.g.* F.iii.1; *Histoire naturelle des animaux*). Conversely, he rejected the mechanist doctrine of an unchanging universe in favour of an explanation in terms of explosion and revolution, as favoured by the life sciences (*e.g.* F.i.269-288; *Des Volcans*). In his *Des époques de la nature* (F.ix.455-668) Buffon identified seven major epochs of revolution. They were far more extensive and devastating than the seven days allowed by the

[8] 'The strongest foe of the detractors of man—strongest because of his scientific prestige—was Buffon'; L. G. Crocker, *An Age of crisis*, p.88.

[9] Y. Laissus, *Le Jardin du roi*, pp.287-341.

[10] J. Roger, *Les Sciences de la vie*, p.552.

Apocalypse, extending in fact over thousands of years. Buffon was the first to express definite opinions on the duration of geological time[11].

Buffon carried his reaction against the mechanical world view to the point of supporting the science of Aristotle (*e.g.* F.iii.9, 471; *Histoire des animaux*). In this vein he argued for four basic elements in matter: 'La matière en général est composée de quatre substances principales, qu'on appelle éléments; la terre, l'eau, l'air et le feu' (F.ix.25; *Introduction à l'histoire des minéraux*). In opposition to the unchanging universe of the mechanists, he emphasised the importance of heat as a dynamic factor which can change the shape of things. He went so far as to reject the study of the physical sciences as being relatively unimportant, as throwing some light on things as they stand, but only by running the risk of over-looking the importance of change. This has led to a debate amongst historians of science as to the extent to which Buffon was in fact a Newtonian[12]. Buffon believed himself to be following in the spirit of Newton, though he rejected the letter of his laws. This rejection is seen most clearly in his substitution of the study of the life sciences for the physical sciences: 'On pourrait donc diviser toutes les sciences en deux classes principales, qui contiendraient tout ce qu'il convient à l'homme de savoir; la première est l'histoire civile, et la seconde l'histoire naturelle . . . la première est l'étude des hommes d'Etat, la seconde est celle des philosophes' (F.ii.28; *Histoire naturelle*).

So great was Buffon's aversion to the generalising tendency essential to mathematics, that he advocated the other extreme of nominalism[13], the study of individual items independently, and without making general statements: 'On va de définitions en

[11] R. Furon, *Earth sciences: the eighteenth century*, p.572.

[12] R. Wohl, 'Buffon and his project for a new science', *Isis* (1960), li.190-199.

[13] E. Cassirer, *The Philosophy of the Enlightenment*, p.79, seems to agree: 'Buffon tends towards outright nominalism, he states that in nature "there are only individuals, there are no species and genera" '.

définitions dans les sciences abstraites, on marche d'observations en observations dans les sciences réelles; dans les premières on arrive à l'évidence, dans les dernières à la certitude' (F.ii.14; *Histoire naturelle*).

Buffon's nominalist methodology reached fruition in his *Histoire des oiseaux*, and in his better known *Histoire naturelle des animaux*, replete with plates in colour, and detailed descriptions, which amazed his contemporaries, and which generated an interest in the study of the life sciences. This in turn resulted in scientific advance. Even if taken on their own, these two histories entitle Buffon to an important place in the history of science. It is of some interest that Buffon justified his nominalist method, his preference for description over generalisation, by reference to Newton: 'Je n'imagine point d'hypothèses; car tout ce qui ne se déduit point des phénomènes est une hypothèse; et les hypothèses ne doivent pas être reçues dans la philosophie expérimentale' (F.ii.28; *Histoire naturelle*). This can be compared with Newton's own view of the matter: 'I frame no hypotheses, for whatever is not deduced from the phenomena is to be called a hypothesis, and hypotheses, whether of occult qualities or mechanical, have no place in experimental philosophy'[14]. Buffon was trying to fulfil what Newton advocated, but practised to a less degree.

Buffon assailed the mechanical world view at what appeared to be its weakest point, namely, its preformation theory[15]. He raised the strongest possible argument against it, which was the 'chain of being' concept. This gave him the advantage of being able to accept new species as they were discovered as being in fact new, which preformation theory disallowed. More importantly, acceptance of the 'chain of being' won for him the support of orthodox believers who all shared this view. This gave him the numbers needed to win the day, to become foremost amongst the

[14] sir Isaac Newton, *Mathematical principles of natural philosophy*, p.547.

[15] R. Wohl, p.193.

exponents of the life sciences in eighteenth-century France. Buffon's own reason for supporting the 'chain of being' was something more than the considerations so far advanced. He was concerned to guard against the dethronement of man. The mechanical world view of the physical scientists, represented in biology by preformation theory, opened the way to naturalism and nihilism, which Buffon was concerned to avoid[16].

Notwithstanding that Buffon's chief reason for supporting the 'chain of being' concept was his humanism, not his self interest, the support of the orthodox, which it won for him, came in especially useful when his science was challenged by the Sorbonne. On 15 January 1751 the Sorbonne condemned fourteen propositions extracted from the *Histoire naturelle*[17]. Buffon's retention of the 'chain of being' concept, and the popularity of his science generally, gave him the time needed to publish a retraction which appeared in the fourth volume of his *Histoire naturelle*, published in 1753. By retracting, Buffon risked the criticism that he lacked courage. In fact, he worked to retain the support of the orthodox to strengthen him in his conflict against his foes amongst the philosophes.

In order to strengthen his position against the mechanistic preformation theory, Buffon varied the 'chain of being' concept in two important respects so as to reinforce it. The trend of these changes was to introduce ferment theory into his argument.

Buffon came out in support of spontaneous generation[18]. This gained for him the considerable advantage of a seemingly incontrovertible empirical proof for his biology, in the form of Trembley's polyp, which, after Réaumur's paper to the Académie des sciences in 1741, was accepted by many as having established biogenesis. At the same time, spontaneous generation provided a disproof of preformation, as these two are incompatible with each other: if the germs were all made in the beginning, then new life is

[16] *ibid.*, p.190.

[17] D. Mornet, *Les Sciences de la nature*, pp.51-52.

[18] O. Fellows, 'Buffon's place in the Enlightenment', *Studies* (1963), xxv. 623.

out of the question. The disadvantage of spontaneous generation was that it is incompatible with the 'chain of being' concept. While the 'chain' can be adjusted as new species are discovered, these being seen as intermediate stages in a scalar process, it requires the belief that life comes through some god-appointed agency. It rejects the idea of life as a result of chance, or being inherent in matter, or as being at the disposition of men.

Buffon was caught in the quandary that his humanism required acceptance of the 'chain of being' concept, and rejection of preformation, while neither theory had been established beyond dispute. While Trembley's polyp seemed to resolve this quandary, by deciding in favour of biogenesis, the solution itself raised a problem. The new dilemma was that spontaneous generation, which would disprove preformation, was incompatible with the 'chain of being' concept. Buffon overcame this objection by a brilliant invention of his own, which revitalised the 'chain of being' concept, and which dealt out to the preformationists the most damaging blow sustained by them in the course of the eighteenth century.

Buffon's invention of the 'moule intérieur'[19] succeeded in creating a bridge between spontaneous generation and the 'chain of being'. The 'moule intérieur' was propounded as a device working within nature which gives its form to organic matter, and which controls generation, development and reproduction[20]. All living things, men, animals and vegetables, have a 'moule intérieur': 'Il nous paraît donc que le corps de l'animal ou du végétal est un moule intérieur qui a une forme constante' (F.i.448; *Histoire naturelle des animaux*). As developed by Buffon, the 'moule intérieur', while it allowed for spontaneous generation, set definite limits on its occurrence. Each 'moule' was set down in the beginning, and all new life must conform with its original model: 'Chaque espèce et des uns et des autres ayant été créée, les premiers individus ont servi de modèle à tous leurs descendants'

[19] J. Roger, *Les Sciences de la vie*, pp.578-582.

[20] R. Wohl, p.192.

(F.iii.417; *Histoire naturelle des animaux*). Accordingly, the 'chain of being' requirement, that no new species can be created, is satisfied, while spontaneous generation is retained. New life is allowed, but within the limits of the existing species.

In order further to differentiate between human existence and other forms of life and, no doubt, to save himself from the theologians, Buffon disallowed spontaneous generation where human life is concerned. For Buffon, human life was a prime example of attraction, as it depended on sex. It provided, at the same time, a proof of the existence of god as the author of life, who demonstrated his existence through attraction. As well as the argument from a first cause, with god as the author of life[21], Buffon's deism depended on the proof of god's existence from attraction[22]. There was no logical or empirical necessity for reproduction to be achieved through sex, or attraction. On the face of it, generation could more simply be achieved by ferment, by 'intussusception' and 'bouture': 'La multiplication des pucerons, qui se fait sans accouplement, est semblable à celle des plantes par les graines, et celle des polypes, qui se fait en les coupant, ressemble à la multiplication des arbres par bouture' (F.i.429; *Histoire naturelle des animaux*). As regards human reproduction, god adopted the less obviously necessary procedure of generation through sex in order to demonstrate his existence.

To enthrone men over nature, and so that they would recognise god's proof of his own existence, the generation of men, unlike that of other forms of life, could only be achieved through attraction. In consequence: 'L'homme est en tout l'ouvrage du ciel; les animaux ne sont à beaucoup d'égards que les productions de la terre' (F.iii.53; *Histoire naturelle des animaux*). For Buffon, growth is determined by 'intussusception', which was the term coined by Montesquieu for how ferment works in generation: 'L'accroissement . . . ne se fait que par l'extension de ce moule . . . cette extension se fait par l'intussusception' (F.i.448; *Histoire*

[21] A. O. Lovejoy, *Buffon and the droblem of species*, p.98.

[22] J. Roger, *Les Sciences de la vie*, p.578.

naturelle des animaux). The sign of the presence of ferment is heat, which is a characteristic feature of all living things: 'On peut rapporter à l'attraction seule tous les effets de la matière brute, et à cette même force d'attraction, jointe à celle de la chaleur, tous les phénomènes de la matière vive' (F.ix.3; *Introduction à l'histoire des minéraux*). Whereas Newton's achievement had been to analyse attraction, Buffon went beyond this to a binary concept of attraction conjoined with heat.

It was with the study of how heat, the life force in men, works its way in the world that Buffon was chiefly concerned. He saw a relationship between heat and electricity, which developed in him an interest in the work of Franklin. Newton's discovery of the importance of attraction could account for inanimate matter, but had the disastrous consequence of mechanising the human predicament if applied to mankind. Buffon intended to transcend Newton's work, to relate it to life, by synthesising attraction with the heat principle of the ferment theorists: 'Les puissances de la nature . . . peuvent se réduire à deux forces primitives, celle qui cause la pesanteur et celle qui produit la chaleur' (F.ix.1; *Introduction à l'histoire des minéraux*). While attraction refers to all phenomena, it needs the additional principle of heat to explain life. Buffon's study of heat, with its emphasis on the possibility of converting one form of energy into another, anticipated modern theories of thermodynamics: 'Toute matière peut devenir lumière, chaleur, feu' (F.ix.7; *Introduction à l'histoire des minéraux*). He was, at the same time, and without necessary contradiction, working out the logic of the alchemist emphasis on transmutation.

The 'moule intérieur' stood for the de-mechanisation of preformation theory, and the triumph of nominalism over generalisation in the study of biology. At the same time, Buffon was able to retain the preformationist emphasis on the hereditary factor by arguing for the 'moule' as being eternal and unchanging (F.i.448; *Histoire naturelle des animaux*). This saved him from the full consequences of his acceptance of spontaneous generation, by setting limits to its occurrence. The 'moule intérieur' also incorporated

the ferment theorists' vitalism, in that the 'moule' was undetectable to the human eye.

The question arises why Buffon, though so near to the modern theory of epigenesis, as pioneered by Maupertuis, was unable to champion it. The answer appears to be that his extremely nominalist theory made the development of generalised principles of biology out of the question, something which Buffon would resist as representing the 'esprit de système', the mechanisation of the world picture, which he was fighting against. Furthermore, the 'moule intérieur', like the germ of the preformationists, emphasised heredity rather than environmental forces. If he shifted from his extremely nominalist position, Buffon would fall victim to preformation theory under a new name[23].

Buffon's opposition to preformation was important less because of the direct contribution it made to the modern theory of epigenesis than because it kept open the debate on preformation. It served to shake the reigning orthodoxy so as to make it possible to progress beyond it. Buffon's testimony against preformation undid the advantage gained for it by the influential advocacy of Voltaire. Montbard was at least as much a place of pilgrimage as was Voltaire's home at Ferney. It was no accident that the problem of generation was being resolved in France while the great debate was in progress.

Notwithstanding that Buffon employed ferment theory, the idea of life from matter, as a basis for his biology, it did not win him the support of other exponents of this position. In particular, Montesquieu and Buffon did not agree[24] in biology. The reason why is because Buffon insisted on the rôle of attraction, which he translated into biology as the sex impulse, as basic to the whole story. To Montesquieu, and to those who thought like him, sex mattered little if at all.

[23] this is possibly why J. Roger, p.583, refers to Buffon as a 'partisan ... de la preformation par le "moule intérieur"'.

[24] D. Mornet, *Les Sciences de la nature*, p.88.

Buffon's emphasis on the importance of sex has been vindicated. This was no obvious matter at a time when other factors were thought to be more important, when parthenogenesis and spontaneous generation were accepted, and when influential scientists, like Linnaeus, rejected it. Buffon must be given most of the credit for the triumph of his form of orthodoxy. During the fifty years he spent in charge of the Jardin du roi, he insisted on an emphasis on sex, or attraction, as a basis for reproduction. This emphasis was instrumental in the vindication of his point of view even in botany, through the work of Jussieu, which, notwithstanding, was rejected by such influential figures as Rousseau and Linnaeus. Buffon did not accept the botany of Linnaeus which, while it employed sexual characteristics to classify plants, adhered to the ferment theorists' explanation of the nature of plant generation.

The clinching point for the vindication of sex was not going to be in botany. The fact that most plants are hermaphrodites raised awkward problems here. It was no accident that Buffon's *Histoire naturelle* does not include a treatment of botany[25]. As far as Buffon was concerned, the problem could best be resolved by reference to the reproduction of animals. Towards this end, Buffon made his greatest contribution to science in zoology. This can be seen in his brilliantly-written *Histoire naturelle des animaux*. His description of the animal world set the stage for the work of Daubenton, who collaborated with him, and Pallas, Vicq d'Azyr, and Cuvier[26].

Buffon was the first to introduce animals, and the study of zoology, to the Jardin du roi[27]. He hoped thereby to advance the study of generation. He was amongst the first in his own day,

[25] 'he might be willing to criticise Linnaeus; but he had no desire to challenge him on his own ground'; R. Wohl, p.195.

[26] M. Flourens, 'Introduction' to *Œuvres complètes* of Buffon, vol.i, p.xviii.

[27] W. F. Falls, 'Buffon et les premières bêtes du jardin du roi: histoire ou légende?', *Isis* (1939), xxx.491-494.

and a more influential advocate than anyone else, for the recognition of veterinary science as an essential field of study[28].

Buffon and Montesquieu differed not only as regards the generation of life. They differed in politics also. The attractionists were normally less democratic in their politics than were the ferment theorists. It is not surprising that Buffon supported the 'thèse royale', for his position at the Jardin du roi depended on the king. However, Buffon was in favour of the 'thèse royale' long before that[29].

Not only were relations strained between Buffon and Montesquieu, but he was not on good terms with Voltaire either. This has caused some surprise[30]. Why were Buffon and Voltaire not more friendly towards each other? Both upheld the 'thèse royale', and each regarded himself as a Newtonian who was concerned to integrate the sciences through the use of the principle of attraction. The most important reason why Buffon and Voltaire disagreed was because, whereas Voltaire was concerned to mechanise the world picture, and to employ Newton's science towards this end, Buffon was just as determined to defeat the mechanists, and to vindicate the life sciences. The paradoxical position developed that both Voltaire and Buffon regarded themselves as the true exponents of what Newton really meant, and each ended with a different resolution of the position.

The difference between Buffon and Voltaire broke out into open conflict in their views on geology. While Buffon was prepared to allow that the world as it stands is no longer subject to major change, that god has handed over control of it to men, he rejected Voltaire's belief that god made the world in its present shape. Buffon favoured instead a belief in revolution as having predominated in the history of the universe: 'La matière brute qui

[28] P. Huard, *L'Enseignement médico-chirurgical*, p.207.

[29] L. Hanks, *Buffon avant l'histoire naturelle*, p.221.

[30] D. Mornet, *Les Origines intellectuelles*, p.98, complains of Voltaire that 'Contre Buffon qui ne lui a pourtant rien fait que gêner sa gloire il ne sait écrire que des puérilités ou des inepties'.

compose la masse de la terre n'est pas un limon vierge, une substance intacte et qui n'ait pas subi des alterations; tout a été remué par la force des grands et des petits agents . . . le globe de la terre a été pénétré par le feu' (F.iii.419; *Histoire naturelle des animaux*).

As far as Buffon was concerned, the earth was fired into life as a result of a divinely-ordained collision with the sun, and shaped by successive revolutions. It was not formed on a one-up basis by a divine artificer. This difference of opinion involved Buffon and Voltaire in a controversy already described, which centred on the discovery of sea shells on top of the Alps. Buffon believed that the whole world was formerly covered with water. This came about as a result of a cooling-down process within the world itself, after it had separated from the sun. A series of mighty explosions next caused the seas to be pushed back, and dry land emerged: 'Tout cela ne doit-il pas nous porter à croire qu'il est en effet arrivé de grandes révolutions sur la surface de la terre, et que la mer a pu quitter et laisser à découvert la plus grande partie des terres qu'elle occupait autrefois?' (F.i.49; *Histoire et théorie de la terre*). The emphasis was on revolution, not on the static universe of Voltaire.

This debate set the stage for the synthesis achieved by Werner, which, although remarkably successful in its day[31], and preparing the way for further advance, was later itself reversed. Only in our own time is it possible to recognise in the opinions of Buffon much that is now accepted as scientific truth[32].

[31] 'the geological dictator of the age was Abraham Gottlob Werner (1750-1817)'; C. Singer, *A Short history of scientific ideas to 1900*, p.328.

[32] P. Lake, *Physical geography*, p.221.

Conclusion

This investigation set out to analyse the debate on science in eighteenth-century France, something which has not been done before. It was found that the controversy provided a stimulus for scientific advance, and at the same time played an important rôle in the thought of the Enlightenment. The recognition of the debate on science has the importance that it unifies the history of science and the history of the Enlightenment. The departmentation of knowledge which is occurring in our own time between historians of science and historians of the Enlightenment has the disadvantage that it can act as a barrier in the way of discovering truth. The distinction can easily be exaggerated when applied to eighteenth-century thought.

In fact, the scientists and the *philosophes* were both working on the same problems, though with a different end in view. The scientists were trying to resolve the dilemma of the imbalance between the life and the physical sciences as far as it affected science. The philosophes were trying to resolve ethical problems inherited from the past, and employing the work of the scientists towards this end. The scientists were intensely interested in what the philosophes were trying to achieve, and vice versa. There were no major barriers between them, and scientist and *philosophe* were not mutually exclusive categories. The debate was not between the scientists and the *philosophes*, but within science, and within philosophy. It proved a catalyst both for scientific advance and for thought about ethics.

What was the importance of the debate on science in eighteenth-century France? The *philosophes* who tried to employ science to establish truths reached by other means found themselves involved in a war between upholders of a mechanical world view, and their foes. The result was that the clash between the

proponents of the physical sciences, on the one hand, and the supporters of the life sciences, on the other, was broadened out into a split within European culture itself. Those who abandoned their Christian beliefs found themselves facing an intellectual crisis of major dimensions. The gods had their revenge.

In religious terms, the controversy may be seen to involve the meaning of the Christian doctrine of the trinity, which is a mystery of faith. The question can be put: which matters more, god the creator, the first cause, or god the holy spirit, the giver of life? The Christian answer is to resolve the dualism through the teachings of Jesus Christ, which involves a trinitarian solution. This integrates two traditions, one of which appears to have more in common with the thought of Plato, and of Pythagoras, and of st Augustine, while the other receives more emphasis, at least analogically, in the thought of Aristotle and of st Thomas Aquinas. The thought of the Enlightenment may be seen as a re-opening of the debate, when other solutions were proposed. Ultimately the choice is between a mystery of faith or a debate without end.

It was a debate with many facets, between deists like Voltaire, who supported the primacy of 'reason', against more earthy deists who, like Rousseau, emphasised fermentation in matter as providing the key to the human condition. It was a conflict between atheists who employed the mechanical world view of Helvétius, compared with those who preferred the life sciences of Diderot as a defence for atheism. It was a debate which percolated through French society, and which still has its echoes in our own time.

Only in the nineteenth century, with the development of the theory of evolution, was it possible for the sciences to develop a working relationship between the claim of the physical sciences to have developed a universal theory of gravitation, and the contrary assertions of the supporters of the life sciences, that matter is in a state of constant change, that probability alone is feasible. In our own time, the debate between universality and particularity

in science has been re-opened by the contribution of Einstein, whose work was in the tradition of the mechanists, and Planck, whose quantum theory is consistent with the beliefs of the eighteenth-century life scientists. This has raised all the old unanswerable questions in new forms. Currently a new modus operandi is being sought. The philosophers have not even found a temporary synthesis. They have gone on debating the issues raised in the Enlightenment, like moths caught between two flames, either of which will destroy them.

On the other hand, the debate was very fruitful for science. It provides the background against which to understand the scientific advance which occurred in eighteenth-century France. The scientists were just as involved as their popularisers in the debate. The controversy was so fierce and so prolonged that it merged into the French revolution, which represented the disintegration of the ancien régime in France. The old order proved to be a fatality in the jungle war between competing factions. The debate freed thought in France. It did not occur in eighteenth-century England because the Newtonians had it all their own way there.

Finally, the debate raised questions about man, and about his relationship to nature, questions which still stand, and which may be unanswerable. If the *philosophes* failed to answer them, it was not from want of trying. Their contributions are still as fresh and as stimulating today as when they were first made. There has been little advance on their answers. This either shows the difficulty of the questions, or else reflects a change in our society, so that the questions which concerned the philosophes no longer interest us today.

A sort of schizophrenia became apparent in European culture in the Enlightenment. This had the advantage that it ensured at least two answers on questions of culture and politics. Furthermore, it fitted well into a pluralist society, and seemed to guarantee freedom. Because the French revolution produced a traumatic effect, it failed to be recognised that a split existed, and it passed from sight. From time to time it has reasserted itself in

different forms, as, for example, in romanticism and nationalism, or in nazism and communism; and, though in less obvious ways, in other guises in every European society, as, for example, in the conflict between realist and abstract art. It is time that European culture be re-examined in these terms if only to guard against such warnings as that of Abraham Lincoln that 'a house divided against itself cannot stand'.

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